



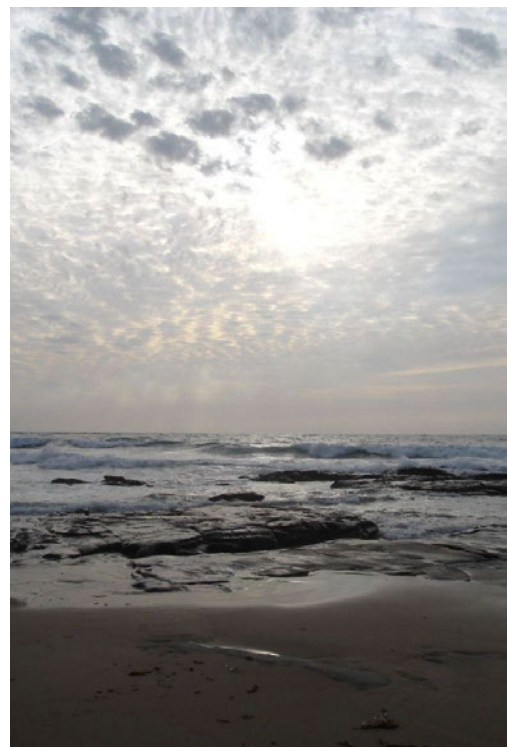
The University of Sydney
Faculty of Architecture



Planning for climate change: Leading Practice Principles and Models for Sea Change Communities in Coastal Australia

Prepared for the National Sea Change Taskforce

July 2008



Nicole Gurrán

University of Sydney

Elisabeth Hamin

University of Massachusetts, Amherst

Barbara Norman

Global Cities Institute, Royal Melbourne Institute of Technology University

CONTENTS

Executive Summary	4
1 INTRODUCTION	8
1.1 The National Sea Change Taskforce	8
1.2 A Typology of Coastal Communities affected by “sea change”	8
1.3 Coastal amenity communities and climate change	9
1.4 Research aims and approach	10
1.5 “Leading” practice in planning for climate change	11
1.6 Report structure	12
2 CLIMATE CHANGE AND AUSTRALIA’S COASTAL AMENITY COMMUNITIES	13
2.1 Understanding climate change	13
2.2 Reducing levels of greenhouse gas emissions, through mitigation strategies	14
2.3 Adapting to potential climate change impacts that are already under way	15
2.4 Implications of climate change for Australia’s peri and non metropolitan coastal communities	17
2.5 Social and economic impacts for coastal amenity communities	18
2.6 Legal liability of local government to consider climate change in strategic planning and development assessment	22
2.7 Conclusion	22
3 LEADING PRACTICE IN PLANNING FOR CLIMATE CHANGE IN COASTAL AMENITY AREAS	24
3.1 Principles for leading practice	24
3.2 Land use planning for climate change mitigation and adaptation	25
3.3 Addressing environmental implications of climate change for coastal amenity communities	27
3.4 Planning for climate resilient economies in coastal amenity areas	29
3.5 Planning for climate resilient populations in coastal amenity communities	31
3.6 Planning for climate resilient infrastructure in coastal amenity areas	33
3.7 Effective coastal planning and urban governance responses to climate change	38
3.8 Conclusion: Building on existing practice and prioritising new opportunities for coastal communities	40
4 CURRENT STATE OF PRACTICE IN PLANNING FOR CLIMATE CHANGE MITIGATION AND ADAPTATION IN AUSTRALIAN COASTAL AMENITY COMMUNITIES	41
4.1 National, state and regional policy and planning for climate change in coastal Australia	41
4.2 States and territories	42
4.3 Local planning responses to climate change in Australian coastal communities	44
4.4 International responses	45
4.5 Summary and conclusion	46



5	ENHANCING PRACTICE IN PLANNING FOR CLIMATE CHANGE IN COASTAL AMENITY REGIONS – LOCAL GOVERNMENT OPPORTUNITIES AND PRIORITIES FOR SUPPORT	48
5.1	Preliminary assessment of community social vulnerability to climate change in amenity regions of coastal Australia.....	48
5.2	Leading practice approaches to climate change: prioritising local actions for multiple benefits	50
5.3	Enhancing practice: priorities for support	57
5.4	Conclusion: Meeting the climate change challenge in coastal amenity communities of Australia	58
6	REFERENCES	61
	Appendix One: National Sea Change Taskforce Members	66



Executive Summary

Climate change has particular resonance for coastal communities. The Intergovernmental Panel on Climate Change (IPCC) identifies coastal areas of Australia as the most exposed to potential climate change impacts, from sea level rise to increased frequency and velocity of extreme weather events (Christensen et al. 2007). These predictions threaten the natural amenity, pleasant climate and beachfront living attractions that define Australian 'sea change' or 'coastal amenity' locations.

The social profile of coastal communities beyond the capital cities compounds their susceptibility to the environmental and economic consequences of climate change. Characterised by lower household incomes, higher proportions of people aged 65 and older, and rapid population growth and change, coastal areas beyond the capital cities combine physical exposure with higher levels of social disadvantage and reduced capacity to adapt to climate risk.

How should local government in coastal areas respond? This report for the National Sea Change Task Force outlines the implications of climate change for sea change communities and explains why new approaches to coastal planning and governance are needed. Many local governments both in Australia and internationally are already developing innovative planning approaches that indirectly improve resilience to climate change, through biodiversity protection, sustainable economic growth, community wellbeing, or non polluting and localised forms of infrastructure and housing. Drawing on this work, the report shows how coastal amenity communities can better plan to mitigate their contributions to climate and adapt to the inevitable changes already underway.

Research aims and methods

The research presented here aimed to:

- Scope the potential environmental, social, and economic implications of climate change for Australia's coastal amenity communities, including a social vulnerability model to indicate communities which need the most assistance in adapting to these impacts;
- Define leading practice in planning for climate change mitigation and adaptation, with a focus on non metropolitan communities in coastal Australia;
- Establish the broader context of current policy and practice in planning for climate change mitigation and adaptation within Australian local government areas, and particularly within non metropolitan coastal areas; and,
- Identify opportunities to extend and enhance this practice at local, state, territorial, and or national levels.

The research methods involved:

- A review of international and Australian literature on climate change, to identify environmental, social and economic impacts for coastal or amenity communities; and to establish best or leading practice principles and approaches in planning to reduce settlement contributions to greenhouse gas emissions, and to adapt to climatic changes already under way;
- An analysis of primary survey data to establish the extent to which Australian statutory planning instruments at local and state levels currently contain provisions relating to climate change preparedness or the minimisation of greenhouse gas emissions;
- A targeted review of local planning practices relating to climate change mitigation or adaptation. The review focused on recent work undertaken by coastal amenity communities in Australia but does include a limited group of leading practice examples from other local government areas in Australia and internationally. The review includes planning approaches directly or indirectly relevant to climate change across five themes: environment, community wellbeing, economy and tourism, infrastructure, and governance; and,



- The construction of an illustrative index of social vulnerability for coastal amenity communities to climate change, focusing on the 67 local government areas represented by the National Sea Change Taskforce. The indicators for the index were defined with reference to known factors affecting community vulnerability natural disaster – including population age characteristics, income levels, length of time within an area, and housing tenure (consistent with Burby et al. 2007, Cutter and Finch 2008, Few 2007, Levine et al. 2007, and Masozera et al. 2007).

Key Findings

Key findings presented in the body of the report are as follows.

Implications of climate change for Australia's coastal amenity communities

- Coastal areas are exposed to climate change risks associated with sea level rise, increased frequency and or velocity of storm events, shoreline erosion, flooding, and changed rainfall and temperature patterns, threatening marine and terrestrial biodiversity and ecosystems (Henessy et al. 2007).
- These environmental risks represent a number of social and economic consequences for coastal amenity communities, exacerbated by existing socio-economic disadvantage and an aging population profile.
- Those in temporary housing like caravans and manufactured homes, are at particular risk in the event of a major natural disaster. These housing forms are an important source of housing for low income Australians and retirees, particularly along the coast. Without proper insurance or ownership of land there is a high likelihood that tenants will face long term displacement in the event of a disaster.
- Other social and amenity impacts for coastal communities include damage to beaches, recreational areas, and landscapes or items of cultural significance. Increased temperatures may make some forms of outdoor recreation – bushwalking, cycling, or golf, less appealing, particularly during summer. Beach and cliff top trails and paths may be subject to more frequent damage and increased exposure to landslip.
- Changed rainfall patterns and increased likelihood of major storm events represent both long term and abrupt unpredictable risks to agricultural and tourism industries, with major flow on implications for non metropolitan coastal economies.
- Over the next 20-30 years extreme weather events are likely to overwhelm existing infrastructure constructed to current design standards. Buildings, roads, railways, ports and airports, bridges and tunnels, will all experience increased pressures and require additional repair, maintenance and upgrading works.

Leading practice in planning for climate change mitigation and adaptation in coastal amenity communities

- The following overarching principles for leading practice emerge from the literature on climate change mitigation and adaptation planning.
 - The need to uphold the principles of ecologically sustainable development in designing adaptation and mitigation approaches, including environmental integrity, social equity and participation, economic viability and the precautionary principle. This is critical for coastal amenity communities whose populations include higher proportions of lower income and socially disadvantaged groups.



- The need to prioritise actions worth doing anyway, which for coastal amenity communities mean actions that have multiple benefits for the environment, for managing coastal processes, for the affordable and efficient provision of infrastructure, for nature based amenity and tourism and for more socially cohesive settlements.
- The importance of a sound evidence base, for identifying and justifying planning responses to climate change. Many smaller coastal councils will need assistance in accessing, interpreting, and applying consistent and reliable sources of scientific information about climate change scenarios.
- The need to plan now, to prevent further risks associated with climate change. Coastal amenity communities experiencing rapid population growth will experience pressure for rapid development approval, before climate change considerations have been factored into planning and assessment frameworks.
- In Australia there is a particular need to review current planning controls to ensure that they 'enable' new adaptive responses in planning for climate, as well as new technology for climate change mitigation.

Current state of policy and practice in planning for climate change mitigation and adaptation within Australian coastal amenity communities

- While climate change is increasingly recognised by Commonwealth and State governments in Australia as a critical issue for coastal communities, few local planning schemes include specific provisions for climate change adaptation or mitigation, aside for controls relating to sea level rise in Western Australia and South Australia.
- However, a growing number of councils have planning provisions that may provide indirect protection from climate change impacts. For instance, 21 of 79 coastal councils responding to a national survey of planning schemes (the Australian Land Use Planning Policy Monitor) report that they include specific coastal protection zones in their planning instrument or equivalent. Other mechanisms that may contribute to the adaptive capacity of local communities under future climate scenarios include bushfire protection zones, overlays or equivalent (41 councils); and provisions to protect wetlands (43 councils); native vegetation (55 councils) and wildlife habitat (48 councils).
- This information suggests that many Australian local councils already have the basis for incorporating climate change considerations within their legislative decision making and development assessment framework but that work needs to be revised in relation to specific climate change scenarios.
- Similarly, many councils have well established approaches to promote more sustainable urban forms, providing a sound basis for reducing harmful greenhouse gas emissions and for settlements that are more resilient to some of the impacts of climate change (particularly increased temperatures and drought). There is an urgent need to build on and extend this work more widely.

Recommendations

Drawing on these findings, we make the following recommendations to enhance practice in planning for climate change across sea change communities in coastal Australia:

1. That all State and territorial planning authorities enact high level planning policy to 'mainstream' climate change mitigation and adaptation considerations in all coastal planning decisions, to ensure long term liveability and adaptability for coastal communities;
2. That in response to climate change, local councils undertake an initial vulnerability assessment incorporating:



- Existing information and potential risks of climate change;
 - The capacity of existing systems or processes to adapt to these impacts; and,
 - The potential to introduce new adaptation strategies.
3. That a formal climate change vulnerability assessment be undertaken at regional or local scales to support strategic land use planning decisions and significant development assessment in coastal amenity areas, including:
- The existing and potential exposure of particular locations / infrastructure to risks associated with climate change and the potential to reduce this vulnerability through specific building standards, development controls, or direct works;
 - The potential impact of the settlement or infrastructure, including the location and configuration of development, on the vulnerability of existing settlements, natural habitat or biodiversity, including 'downstream' impacts;
 - The location of existing and planned settlements / developments in relation to access routes, services, and infrastructure, and the likelihood of continued access to these facilities in the event of an emergency, and;
 - The potential to reduce risks and the potential to further adapt the development / activity if climate impacts accelerate or increase.
4. That carbon impact of future land use or development forms must become an explicit consideration in all strategic land use planning and development assessment processes in coastal areas, including:
- The ability to service locations with alternative transportation, like public transport, walking, and biking, and the general contribution of the location to reductions in auto trip numbers and length, to assure that the location works toward climate change mitigation;
 - The scale and duration of the impact, both of the primary development itself (and associated construction), and potentially, any 'downstream' impacts.
 - Ways to avoid, negate, or offset the impact of the development on greenhouse gas emissions and any existing or potential legal duty of care to consider direct or indirect carbon impacts of the development.
5. That in any adaptive response to climate change, consideration be given to the possible 'equity' issues that may arise as a result of financial (eg. pricing policy) or regulatory (eg. building codes), and the differential impacts for particular members of coastal communities that may be particularly vulnerable to pricing or regulatory changes.
6. That a mechanism be established to encourage and enable collaboration between neighbouring local councils in responding to climate change.
7. That Federal and State governments support local councils in building expertise and in undertaking the necessary vulnerability assessments and adaptation planning work with dedicated funding and data resources.
8. That further research on understanding and responding to social vulnerability to climate change impacts be undertaken, with priority assistance given to coastal areas where physical exposure, socio-economic disadvantage, and population instability coincide.
9. That an intergovernmental agreement involving all three levels of government be developed to clearly state the commitments and responsibilities of Federal, State and Local Government in planning for climate change.



1 Introduction

Australia's coastal communities are facing many serious and widely documented challenges. Beyond the capital cities and along the coastal perimeter of peri urban areas, coastal towns have always been vulnerable to extreme weather events. However, rapid urban expansion within new and existing coastal settlements, due to growing populations and numbers of visitors, means that major storms and floods – such as cyclone Larry in Northern Queensland in 2006, the NSW Central Coast floods of 2007, or the flooding of the northern rivers and south east Queensland in early 2008 – now affect many more people and threaten the coastal infrastructure and industries they depend on. Such impacts are all the more significant given that existing infrastructure and services – particularly water, waste management, roads, and recreational facilities – are already overstretched. Precarious local economies relying on tourism and related industries – retail and hospitality; as well as agriculture – are particularly exposed to direct and indirect damage from major natural disasters. Coastal populations – often older than Australians overall; and situated in dispersed, single road access point settlements – are particularly vulnerable when disasters strike.

If, and when, such existing hazards intensify due to climate change, the impacts for coastal communities will be devastating. But climate change also brings new threats for coastal communities, particularly those communities that are oriented towards natural amenities and lifestyle, referred to in this report as 'sea change' or 'coastal amenity' areas. Impacts like increased rainfall in some areas and decreases in others, hotter temperatures and humidity, and more bush fires represent significant additional risks for coastal amenity communities – affecting population health, safety and lifestyle; the natural environment, and local and regional economies (Norman 2008). There is an urgent need to assess the existing capacity of these communities to adapt to such risks.

This report outlines the implications of climate change for sea change communities and explains why new approaches to coastal planning and governance are needed. Many local governments both in Australia and internationally are already developing innovative planning approaches that indirectly improve resilience to climate change, through biodiversity protection, sustainable economic growth, community wellbeing, or non polluting and localised forms of infrastructure and housing (Atkinson et al. 2007, Footitt et al. 2007, Gurran et al. 2006, The Climate Impact Group 2007). Drawing on this work, the report shows how coastal amenity communities can better plan to mitigate their contributions to climate and adapt to the inevitable changes already underway.

1.1 The National Sea Change Taskforce

The National Sea Change Taskforce (NSCTF) was formed to assist local governments in coastal Australia address the challenge of rapid coastal growth and change. The NSCTF includes over 60 local government authorities in coastal New South Wales, Queensland, South Australia, Tasmania, Victoria and Western Australia, accounting for around half of the nation's non metropolitan coastal local government areas (see Appendix 1). A key objective of the NCSTF is to develop innovative and best practice strategic planning for coastal amenity areas, to preserve local character and sense of place, integrate coastal management and conservation objectives with economic development, build social capital, and ensure community ownership and participation in key growth decisions.

The research presented in this report contributes to this objective. It follows a series of research papers completed by the University of Sydney, in partnership with Australian coastal communities represented by the NSCTF.

1.2 A Typology of Coastal Communities affected by “sea change”

“Sea change” is a term commonly used in Australia to describe lifestyle driven population growth and change within non metropolitan and peri metropolitan coastal areas (Burnley and Murphy 2004). This population growth differs from other types of growth as newcomers are attracted primarily for lifestyle or amenity reasons, rather than to improve their economic circumstances through a new employment



opportunity. While jobs arise to service the new populations in amenity or lifestyle regions, many newcomers have reached retirement or pre retirement while others commute or telecommute to the capital cities. Sea change in Australia mirrors an international phenomenon known as “amenity migration”, where people move to be closer to natural amenity and lifestyle opportunities (Marcoullier et al. 2002, Shumay and Ostterstrom 2001, Steward 2000).

Population movements associated with ‘sea change’ or amenity migration affect coastal communities across Australia in different ways. Many of these differences can be explained by understanding the locational, settlement, and population variations that characterise coastal amenity communities. We have distinguished a broad typology of Australian coastal communities affected by amenity driven population change (Gurran et al. 2005).

This typology includes five broad “ideal types”:

- Coastal Commuters - suburbanised satellite communities in peri metropolitan locations;
- Coastal Getaways - small to medium coastal settlements and groupings of settlements within three hour’s drive of a capital city;
- Coastal Cities - substantial urban conurbations (populations above 100,000 people) situated beyond the State capitals;
- Coastal Lifestyle Destinations - predominantly tourism and leisure communities, located more than three hours drive of a capital city; and,
- Coastal Hamlets - small, remote coastal communities often surrounded by protected natural areas, with populations below 15,000 people and situated more than three hours drive of a capital city.

Policy and planning responses, including responses designed to address climate change, should be sensitive to these different community types. In this report we use the term ‘coastal amenity community’ to refer to the spectrum of peri and non metropolitan coastal local government areas known for their natural amenity, tourism, or lifestyle appeal. As noted above, about half of all coastal local government areas beyond the capital cities fall within these characterisations.

1.3 Coastal amenity communities and climate change

Climate change threatens all Australian communities but coastal areas are under particular pressure. These pressures arise both from the well documented physical exposure of low lying coastal areas to extreme climate change impacts and the particular demographic characteristics and changes affecting coastal populations beyond the capital cities.

- Coastal amenity and lifestyle attractions are crucial to the economic and social wellbeing and appeal of sea change communities, but these attributes are at particular risk of both long term climatic changes and sudden unpredictable weather events. Planning and adaptation responses need to focus on maintaining their amenity and lifestyle qualities.
- However, the rapid pace of growth in many coastal amenity regions means that there is a real risk that planning authorities will continue along a standard development path and defer considerations about climate change impacts until it is too late.
- Rapid population growth or change itself is associated with increased vulnerability to natural hazards as newcomers are not accustomed to disaster protocols and as more lives and property are exposed to risk (Cutter and Finch 2007).
- The demographic profile of coastal amenity communities is associated with increased social vulnerability to climate change impacts, as we outline in subsequent chapters of this report.
- Coastal amenity communities are often poorly resourced due to the size of their rate base, remoteness, and difficulties in attracting trained staff. They often span a very large and varied



geographical area which might typically contain multiple micro climatic conditions and many distinct ecosystems, unlike local authorities in metropolitan regions, who service more contained areas.

1.4 Research aims and approach

There has been considerable effort to understand the science of climate change – its causes and its likely effects. Undoubtedly there is far more scientific research to be done in this area. Coastal communities in Australia themselves urgently require access to consistent and reliable spatial data about the likely impacts of climate change at the local level, as we emphasise later in this report. Of equal priority is research matching existing scientific information to decision making processes on the ground (Vogel et al. 2007). To date there has been relatively little work on the range of interventions that local governments, along with other levels of government, need to take to help their communities respond to climate change.

However, information is now emerging to guide policy makers and planning practitioners in ensuring that future growth decisions consider potential change in climatic conditions (eg. New Zealand Climate Change Office 2004, ODPM 2004, SKM 2007, SMEC 2007). Much of this knowledge base is drawn from practice in the field, as local authorities throughout the world begin to assess their vulnerability to climate change and identify opportunities to strengthen their land use and infrastructure planning to reduce their ongoing contributions to greenhouse gas emissions (eg. Burton 2007, CCP 2007, The Heinz Centre 2007, UKLGA 2007). Much of this work has been undertaken by relatively well resourced local authorities within major cities, but there are still lessons to be learned for smaller local governments in regional areas.

This report synthesises the existing information and practice examples and interprets it in relation to the particular contexts affecting Australia's non metropolitan and peri metropolitan coastal communities. It seeks to understand the current state of policy and planning in relation to climate change and Australian coastal communities beyond the capital cities. It also aims to provide a policy guide and information resource for local councils in these areas to protect their communities and ways of life from the impacts of climate change through better settlement planning and development control.

The research aimed to:

- Scope the potential environmental, social, and economic implications of climate change for Australia's coastal amenity communities, including a social vulnerability model to indicate communities which need the most assistance in adapting to these impacts;
- Define leading practice in planning for climate change mitigation and adaptation, with a focus on non metropolitan communities in coastal Australia;
- Establish the broader context of current policy and practice in planning for climate change mitigation and adaptation within Australian local government areas, and particularly within non metropolitan coastal areas; and,
- Identify opportunities to extend and enhance this practice at local, state, territorial, and or national levels.

The research methods involved:

1. A review of international and Australian literature on climate change, to identify impacts for coastal or amenity communities; and to establish best or leading practice principles and approaches in planning to reduce settlement contributions to greenhouse gas emissions, and to adapt to climatic changes already under way;
2. An analysis of primary survey data to establish the extent to which Australian statutory planning instruments at local and state levels currently contain provisions relating to climate change preparedness or the minimisation of greenhouse gas emissions in urban development;



3. A targeted review of local planning practices relating to climate change mitigation or adaptation. The review focused on recent work undertaken by coastal amenity communities in Australia but does include a limited group of leading practice examples from other local government areas in Australia and internationally. The review includes planning approaches directly or indirectly relevant to climate change across five themes: environment, community wellbeing, economy and tourism, infrastructure, and governance; and,
4. The construction of an illustrative index of social vulnerability for coastal amenity communities to climate change, focusing on the 67 local government areas represented by the National Sea Change Taskforce at the time the research was carried out. The indicators for the index were defined with reference to known factors affecting community vulnerability to natural disaster – population age characteristics, income levels, length of time within an area, and housing tenure.

The primary survey data noted in bullet (2) above comes from the Australian Urban Land Use Planning Policy Monitor, a database established by researchers at the Universities of Sydney and Western Sydney (<http://ppm.arch.edu.au>). It currently contains detailed information about the planning frameworks of more than 100 local authorities throughout the Australian states and territories. The data measures how local statutory plans address a range of policy objectives, including coastal protection, sustainable settlement and transportation, energy efficiency, water saving, biodiversity protection, and housing. It also tracks specific statutory planning approaches for considering the impacts of a development on climate change contribution or risk.

A special data run was undertaken to determine the extent to which Australian local governments are addressing climate change mitigation and or adaptation through their statutory land use planning frameworks, either directly (with reference to climate change, greenhouse gas emissions, sea level rise or enhanced flood risk) or indirectly (through innovative measures relating to sustainable urban form, energy, water, waste management, or biodiversity protection).

The index of social vulnerability for coastal amenity communities to climate change noted under bullet (4) above was constructed using the following sources of 2006 ABS Census data:

- Median Age (communities with a higher median age were given a lower rating);
- Median Income (communities with a lower median income were given a lower rating);
- Recent in-migrants (communities with a higher proportion of people who moved from outside the LGA in the past five years were given a lower rating); and,
- Renters (communities with a higher proportion of rental properties in the LGA were given a lower rating).

Further details about this source data and other population and economic trends characterising communities affected by sea change is contained in the Meeting the Sea Change Challenge Update Report and Data Supplement 2008 (Gurran and Squires forthcoming).

1.5 “Leading” practice in planning for climate change

Over the past decade much research has focused on the potential to build policy and practice by identifying and disseminating examples of leading or “best” practice in the fields of public policy, planning, natural resource management and tourism (Testoni 2000, Bretschneider et al. 2005). The research undertaken here falls within this tradition. In this report we refer to leading practice in planning for climate change in terms of “ideal” approaches or principles as a basis for evaluating existing and potential program and planning responses. We identify principles to guide coastal amenity councils in planning for climate change drawing on the national and international literature (Bulkley and Bletsill 2003, Burton 2007, ODPM 2004). We then point to examples to show how these principles might be implemented in practice. These examples often represent leading practice in sustainable planning, irrespective of climate change, but have been selected to demonstrate existing and potential strategies



for addressing key issues that are likely to become more pressing for coastal amenity communities under future climate scenarios.

Practice in planning for climate change mitigation and adaptation is at an early stage of development (Bulkeley and Betsill 2003, ODPM 2004, PIA 2004). While it is premature to assess this emerging work as “best practice” or otherwise, in this report we use the term “leading practice” to refer to specific approaches that represent a positive attempt to respond to climate change. We focus on approaches that seek either to reduce local contributions to global warming through better settlement planning, those that seek to improve the capacity of coastal communities to adapt climate change impacts, or those that seek to do both.

1.6 Report structure

Following this introductory chapter, the report is structured in four parts:

- Chapter two outlines key concepts associated with climate change and implications for Australian coastal amenity communities.
- Chapter three outlines leading practice principles and models for addressing climate change through strategic planning and development assessment frameworks, focusing on five themes: environment, community, economy, infrastructure and governance.
- Chapter four reviews the current state of practice in strategic planning for climate change mitigation and adaptation in Australian coastal amenity communities.
- Chapter five outlines opportunities to enhance this practice. It presents a matrix of approaches to climate change mitigation and adaptation, emphasising the potential for approaches to deliver multiple benefits for the environment, community, economy, infrastructure and coastal governance. The chapter also outlines how other levels of government can best support local coastal communities in this work. It concludes with a summary of recommendations for all levels of Australian government to support coastal amenity communities to adapt to the potential impacts of climate change.



2 Climate change and Australia's coastal amenity communities

This chapter explains key concepts associated with the causes and management of climate change, and the implications for coastal amenity communities in Australia. The first section introduces the basic science of climate change, and outlines international practice reducing greenhouse gas emissions and adapting to impacts that are already under way. Ways of understanding and assessing risk and vulnerability to climate change impacts are also introduced. The chapter then summarises forecast environmental impacts of climate change in coastal Australia, emphasising that much uncertainty remains about the scale of these impacts, particularly at the local level. The final section scopes the social and economic implications for coastal amenity communities.

2.1 Understanding climate change

Climate change refers to the processes of changes in the earth's atmosphere over time (IPCC 2007c). Some climatic variations occur naturally. However, the rate of climatic change has increased significantly over the past two hundred years and particularly in the past century. These changes are largely triggered by shifts in the earth's atmospheric gases – increasing concentrations of greenhouse gases, which have a warming effect on temperature, and aerosols, which have a cooling effect. They have resulted in an overall warming of the earth's climatic system, colloquially called “global warming”. Melting of the northern hemisphere snow caps, and increasing global average sea levels are associated impacts of this global warming process.

Increased concentrations of greenhouse gases such as carbon dioxide, are attributed to the burning of fossil fuels. Changes in land use have exacerbated the problem as some types of land use – like forest cover – absorbs carbon dioxide (Fisher et al. 2007). When forests are lost, these carbon “sinks” disappear too. Global warming itself reduces natural land and ocean absorption of carbon dioxide. This creates a “carbon cycle feedback” loop that means that even major reductions in current levels of greenhouse gas emissions will not prevent a level of ongoing climatic change.

Ultimately, the IPCC concludes that even if greenhouse gas emissions stabilise soon, “anthropogenic warming and sea level rise would continue for centuries due to the timescales associated with climate processes and feedbacks” (IPCC 2007a, p. 17).

However, if existing rates of fossil fuel use and land use change continue at present or greater levels, the IPCC warns that rates of climate change will likely increase too. This means that it is critical to reduce levels of greenhouse gas emissions as quickly as possible. It is also essential to prepare for and adapt to the climatic changes that are unable to be avoided. This is achieved through both mitigation actions, which reduce net carbon emissions and to limit climate change over time, and adaptation actions, which enable humans and natural systems to accommodate the impacts of climate change (Fisher et al. 2007). Mitigation, then, helps reduce local carbon footprints, while adaptation helps to reduce the local impacts of unavoidable climate change.

The built environment is a key contributor to greenhouse gases. The largest proportion of the total greenhouse gas emissions arise from fossil fuel combustion in Australia (around 49 per cent) and are mainly attributable to energy consumption for manufacture of building materials plus the heating and cooling in buildings (ABS 2003; Beeton et al 2006). Australia is not unique. In the United States, buildings account for 65 per cent of electricity consumption; 36 per cent of energy use; 30 per cent of greenhouse gas emissions, and 30 per cent of raw materials use (U.S. Green Building Council 2008).

The patterns in which we build our communities are essential contributors to either increasing or abating emissions, particularly in relation to the need for motorised transport. In Australia, road transport activity accounts for 14 per cent of greenhouse gas emissions, over 70 per cent of which is road based transport. Passenger vehicles contribute 45 per cent of the total transport emissions (Beeton et al. 2006). In the United States, transportation now accounts for a full third of carbon dioxide emissions, and that share has risen from 31 percent in 1990 to 33 percent today (Ewing et al. 2007). With business as usual, the share is unlikely to decrease in the future. Rather, the U.S. Department of Energy's Energy Information Administration (EIA) forecasts that driving will increase 59 percent



between 2005 and 2030, while U.S. population only increases a projected 23 percent (Ewing et al 2007). Australia's greenhouse gas emissions from private motor vehicles are also growing (Beeton et al. 2006).

Box One: International Policy Context

The international policy framework for climate change is established by the United Nations Framework Convention on Climate Change (UNFCCC). The Framework Convention was introduced at the Rio de Janeiro Summit in 1992 and came into operation in 1994. Within this framework, the Kyoto Protocol was established in 1997. Under the Kyoto Protocol, 36 signatory countries work towards targets for reducing their greenhouse gas emissions over time. Australia committed itself to these legally binding emission limitation and reduction commitments at the international climate change meeting held in Bali in December 2007. The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental scientific body established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Program (UNEP). Its role is to provide neutral advice about the causes of climate change, likely socio economic and environmental impacts, and potential policy responses.

The International Council for Local Environmental Initiatives (ICLEI) is an international association of over 700 local governments and national and regional local government representative organisations committed to environmentally sustainable development. The Cities for Climate Protection Program is a key campaign of the ICLEI. This program guides local governments in preparing policies and measures to reduce local greenhouse gas emissions. This work has focused on the range of mitigation efforts including education and awareness raising, using renewable energy, and sustainable waste management. They have recently undertaken a study of local adaptation responses as well; the full study is available at: <http://www.iclei-usa.org/programs/climate/adaptation>.

2.2 Reducing levels of greenhouse gas emissions, through mitigation strategies

Globally, total annual emissions of greenhouse gases are continuing to rise (IPCC 2007a). Without significant policy intervention, it is expected that these emissions will continue, and that dependence on fossil fuels for energy will grow. Although increases in emissions are likely to occur mainly in developing nations, on a per capita basis the emissions in developed nations will remain much greater. Scientific experts continue to seek to identify levels of climate change that might be acceptable without leading to significant ecosystem risk, but given the complexity of climate modelling, some uncertainty regarding the cause and impacts of climate change will remain. Nevertheless, scientists argue that mitigation actions are still necessary to reduce the overall risks of climate change at both global and regional levels (Rogner et al. 2007, p. 101).

The objective of mitigation strategies is to reduce the harmful carbon dioxide emissions that contribute to climate change. While much of the emphasis of mitigation measures has focused on using the market to make carbon generation more expensive, there are also a number of measures identified by the IPCC that relate to settlement planning and infrastructure.

In relation to buildings, the IPCC advises the introduction of environmental standards, building codes and certification, and the management of energy and water requirements through design and use of appliances. It proposes incentives and regulation for improved agricultural land management and forests, particularly regulations to reduce deforestation and to maintain and manage forests (Fisher et al. 2007). The IPCC also recommends improved waste and waste water regulation and the introduction



of renewable energy incentives and requirements (IPCC 2007b). These issues have been raised most recently in Australia in the context of the Garnaut Climate Change Review (2008).

Land use changes provide an important form of mitigation against the enhanced greenhouse gas effect. If we continue to build in forms that are common today, the increases in driving noted above will overwhelm any improvements in vehicle efficiency. As a result, changes in vehicle miles travelled are necessary to stabilise or reduce emissions (Ewing et al. 2007). The most well-researched form of mitigation is through building in ways that decrease the need to drive, by improving urban design, improving connectivity, and providing for good alternatives to automobile travel, such as well designed bikeways and sidewalks and public transit. A 2007 study by Ewing et al. finds that “households living in developments with twice the density, diversity of uses, accessible destinations, and interconnected streets when compared to low-density sprawl drive about 33 per cent less” (Ewing et al. p. 2).

Climate change mitigation scenarios assume that technological advances will make emission reductions possible later this century. These technological advances relate to reducing demand for water and fuel, shifting to renewable sources of energy, and carbon capture or storage (Fisher et al. 2007). Opportunities for carbon free and renewable energy forms including hydro power, wind, solar power, and biomass are facilitated by the incentives and constraints imposed through local planning instruments and decision processes. Land use change, again facilitated by effective planning controls and decisions, can also promote increases to vegetation and forest cover, improving potential for carbon sequestration in rural areas. Within an emissions trading framework, such environmental technologies and green approaches may contribute to local economic opportunities. We return to these approaches and their particular implications for Australian coastal communities in chapter three.

2.3 Adapting to potential climate change impacts that are already under way

As noted above, irrespective of mitigation efforts, significant climate change processes are already underway. It is imperative to adapt to these impacts in the short to medium term (IPCC 2007a). Adaptation measures are primarily implemented at the local scale (Fisher et al. 2007). Local government must adapt to the direct risks to human safety, property, infrastructure, services, industry and the local environment. However, decisions about the appropriate adaptation measures to undertake are complicated by the uncertainty surrounding climate change scenarios, particularly their impacts at the local scale. Due to this uncertainty, it is helpful to consider the goal of local planning for climate change to be the encouragement of resilience in the built and social environment, so that both humans and other species are better able to accommodate changes, whether small or disastrous, in stride.

Risk

The concept of “risk” is central to understanding the implications of climate change and the range of responses needed at global, national, and local scales. Most definitions of risk combine two concepts: level of probability that a given event will occur, and the scale of impact or consequences arising from the event (New Zealand Climate Change Office 2004). Risk associated with climate change is then assessed in relation to both of these factors (Voice et al. 2007). So high probability, combined with high potential impact, signifies high risk (Allen Consulting Group 2005, Holper et al 2006).

Undertaking a risk assessment requires sound information about projected climate change scenarios over time, as well as an analysis of affected assets and population – from the natural landscape to the built environment, to permanent and visitor populations, and plants and animals. Once the level of risk is considered options to manage this risk are then evaluated. What measures may be undertaken to reduce these risks, and what are the potential costs, benefits, or risks to other systems arising from such measures? Greater capacity to adapt means greater resiliency to climate change.

A different way to think of the same is thing is this: In human communities, the level of potential impact is directly related with the physical and social infrastructures in place – hurricanes where there are no



structures or people are not really a problem; the problem is the combination of the event and the physical and social framework within which it happens. Not all social and environmental systems are equally vulnerable to the risks of climate change. Thus, the goal of resiliency planning is to build in the physical and social structures that will minimise the human and non human impacts of climate change.

Vulnerability

Vulnerability is understood as a combination of exposure (risk) and capacity to respond (resilience) (Allen Consulting Group 2005, Vogel et al. 2007). Many of the actions identified in this report to enhance resilience focus on the built and natural environment. But there are also social and economic factors influencing the vulnerability, or capacity to adapt to climate change impacts, of a given population or group. For instance, much risk management research focuses on the magnitude of economic costs associated with a natural disaster. However, if these losses are incurred by people who are adequately ensured and have additional financial resources, their capacity to adapt and recover will be much greater than that of lower income groups whose overall losses may be smaller in absolute terms but for whom the capacity to recover will be limited by their financial means (Masozera et al. 2006). We return to the issue of social vulnerability later in this report.

Standard approaches for adapting to coastal hazards provide a basis for thinking about physical planning strategies to prepare human settlements for increased storm events, shoreline erosion, coastal flooding and sea level rise. These options include:

- assisting natural systems to adapt to the potential hazard, for instance, by re-establishing foreshore vegetation to reduce erosion or importing sand to protect a beach;
- accommodating the hazard by preventing new permanent development within areas at risk;
- establishing or reinforcing barrier devices to protect property, infrastructure or settlements (such as a levee bank or sea wall); and
- removing permanent structures from the hazard area through a process of managed retreat (Gurran et al. 2006., p. 28, adapted from Walsh et al. 2004).

The policy goal in relation to adaptation is to increase resilience to potential climate change impacts and reduce vulnerability.

Building resilience

Local governments are most likely to be responsible for the range of actions needed to increase the resilience of their communities to climate change. To do this effectively, an initial vulnerability assessment, incorporating existing information about potential risks of climate change, the capacity of existing systems or processes to adapt to these impacts, and the potential to introduce new adaptation strategies, is required (see Centre for Science in the Earth System 2007; <http://cses.washington.edu/cig/fpt/guidebook.shtml> for latest best practice in undertaking a local risk assessment).

Many actions are beyond the legislative and financial capacity of local government and require a partnership with State or in some cases national government. Possible models include Victoria's Western Port Greenhouse Alliance, which comprises coastal councils to the south east of Melbourne, and undertakes joint projects on climate change mitigation and adaptation, with funding support from State government. We return to need for stronger processes and partnerships to address climate change in coastal Australia in the final two chapters of this report.



2.4 Implications of climate change for Australia's peri and non metropolitan coastal communities

Climatic changes are already affecting Australian coastal areas (Hennessy et al. 2007). These changes include rising temperatures, more heatwaves, more rain in the north west and less rain in southern and eastern Australia. They are already resulting in water shortages, agricultural impacts, and pressure on natural ecosystems.

Continued climate change will impact Australian coastal communities in different ways. Regional location, the physical characteristics of each settlement, population structure, local economic base, rates of growth, technological change and changes in human behaviour are all important factors to understand when assessing the relative vulnerability of coastal communities to the risks associated with climate change. In broad terms these risks include a range of specific climatic and environmental hazards each of which have implications for human populations in terms of health and safety, property and infrastructure, local industries, services and transportation, lifestyle and leisure. As scientific data becomes more available at smaller spatial scales, temperature and rainfall patterns will reveal significant local variation.

Current science suggests the following for the different regions of coastal Australia. Temperatures are expected to rise by between 0.7--0.9 degrees by 2030 across coastal areas of Australia, although southern areas such as Tasmania will experience lower increases (CSIRO 2007). There is likely to be greater variation in temperatures in some areas and more extreme temperatures, with increased frequencies of hot days and warm nights. Within settled areas, population growth will increase what is known as the "urban heat island" effect, exacerbating peak energy requirements and global warming (Hennessy et al. 2007). These severe power peaks will bring more blackouts, impacting on industry, human services, and health.

Global sea level rise is anticipated to be between 18-59cm by 2100, although this may increase significantly depending on the rate of ice sheet melting. Sea level rise and warming sea temperatures will exacerbate the impacts of storm surges, meaning that flooding and extreme waves will move further ashore, threatening beaches, settlements, and natural ecosystems (CSIRO 2007, p. 11). For instance, modeling based on cyclone data in the Cairns region shows increases in cyclone intensity of about ten per cent, with increases in frequency from a 1-in-100 year event to 1-in-70 year event, and a doubling of the area affected by inundation (Christensen et al. 2007, p. 916).

Rainfall is likely to decrease in southern areas, especially the south west by 2030 but by 2050 changes will be larger. Other areas will experience increased overall rainfall but this is likely to be experienced through intense rainfall periods interspersed with more dry days.

There is likely to be increased wind speeds across coastal areas by 2030, with larger increases later in the century. Across south eastern Australia, fire seasons are projected to extend and they will be more likely to affect coastal areas as well as inland ones. There will be more frequent fires, their intensity will increase, they will spread faster and be more difficult to extinguish (Hennessy et al. 2007).

Natural ecosystems have limited capacity to adapt to enhanced climate change impacts. Already many species in coastal areas are at the limits of their range due to habitat isolation, fragmentation, and intrusion by invasive species. The long term temperature and rainfall pattern shifts and increased intensity of extreme events are expected to affect all vegetation communities, further impacting the habitat of terrestrial species. Sea level rise and the inland intrusion of salt water, as well as drought and decreased river flow, will affect species dependent on freshwater habitats as well as estuarine areas and coastal fisheries (Hennessy et al. 2007).

The IPCC identifies coastal Australia South East Queensland, the Queensland Wet Tropics, Kakadu and South Western Australia as coastal "hotspots" of particular climate change vulnerability (Table 1).



Table1: Coastal “Hotspots” identified by the IPCC (2007)

Region	Risks
Queensland Wet Tropics	Many species face extinction under moderate emission scenarios. Coral reef bleaching events and deterioration. Sea level rise, flooding, and cyclone storm surges.
South East Queensland	Rising sea level, storm surges, flooding, threatening existing and projected buildings and infrastructure.
Kakadu	Rising sea level, leading to salt water intrusion, extension of mangroves displacing freshwater wetlands
South western Australia	Water shortages, reduction and fragmentation in plant species range. Impacts for crops.

Source: Henessy et al. 2007, p. 530

Climate change is already affecting the world heritage listed Great Barrier Reef (GBR) in far north Queensland. Rising sea temperatures “are almost certain to increase the frequency and intensity of mass coral bleaching events”, with annual bleaching predicted by 2030 (Henessy et al. 2007, p. 527). There have been eight mass bleaching events since 1979 and no records of events prior to this time.

2.5 Social and economic impacts for coastal amenity communities

Given these weather forecasts, a variety of outcomes can be expected, summarised in table two.

Economy

Agriculture remains an important sector for most local coastal economies beyond the main capital cities, but faces new threats from increased temperatures, drought, and storm events. Similarly, warming sea temperatures and sudden storm events and flooding represent severe risks to marine life, with significant consequences for local fishing industries.

Impacts to agriculture from climate change will affect different areas in very different ways. Agricultural industries and forestry production are likely to decline by 2030 across southern and eastern Australia, due to increased drought and fire (Depelege 2007), although some new opportunities associated with changed weather patterns may arise in some regions.

Many areas will need to adjust their agricultural practices. While many traditional agricultural practices, such as grazing, are only minor problems in the event of a flood, new forms of intensive agriculture such as confined animal feeding operations may represent a much more significant risk to local water systems because they represent a major intensification of untreated wastes. Yet many local plans permit all forms of rural industry on land that is zoned for agriculture, without distinguishing between types of activity. To ensure that local councils are able to assess the environmental impact of new agricultural practices it may be necessary to amend local plans to require consent for certain types of more intensive rural industry.

Tourism and related hospitality and retail industries is increasingly important for coastal communities but many coastal tourism destinations will loose market share if perceived climate change impacts are too great. Perceived and actual health and safety concerns in coastal areas from storm risk or disease outbreaks are likely to diminish tourism markets in areas most affected. Tourism associated with the Great Barrier Reef alone is currently responsible for about 63,000 full time equivalent jobs and generated over US \$4.48 billion between 2004/05; many of these jobs will be at risk if the reef is significantly impaired from climate change impacts (Henessy et al. 2007).

While climate change represents many economic threats to the wellbeing of coastal amenity communities, there may also be some new opportunities for communities that respond early. These opportunities depend largely on the particular climatic characteristics of each community. They might include an extended tourism season due to longer summers and warmer year round temperatures or new or increased opportunities for agricultural production, due to changed rainfall patterns. There is



considerable opportunity to develop knowledge and innovation in climate change responses and technology – particularly renewable energy generation. The geography of many coastal amenity communities in Australia means that they may be well placed to undertake research and development in this field.

At the same time, local and regional agricultural production will become increasingly important if freight costs increase due to fuel shortages. The capacity to source food from within a local or regional catchment is also an important principle of sustainability and a way of decreasing contributions to greenhouse gas emissions. Gourmet and niche agricultural production adds value to local tourism and contributes to amenity and local quality of life. Local climate change vulnerability assessments must ascertain the threats to existing agricultural industries and practices, as well as the measures required to enable agricultural production to continue in the future.

Financial implications of increased damage from natural disasters are significant. In current terms, average annual costs associated with natural hazard events in Australia (storms, floods, cyclones and fires) were US \$719 million between 1967-1999 (Henessy et al. 2007, p. 511). In March 2006, tropical cyclone Larry alone caused damage to buildings, industry, utilities, roads, transport systems, schools, hospitals and communications systems amounting to US\$263 million (ibid).

Infrastructure

Infrastructure will be under increased risk and by 2030 extreme weather events are likely to overwhelm some existing infrastructure constructed to current design standards (Henessy et al. 2007, p. 509). Buildings will experience increased damage. Roads, railways, ports and airports, bridges and tunnels, will all experience increased pressures and require additional repair, maintenance and upgrading works. Telecommunications services, water and energy utilities are all associated with particular risks and hazards. Individual property values may be affected by increased exposure to climate change risk including flood, fire, and storm damage.

Floodplain protection models and requirements, as well as urban water systems and bushfire protection requirements are all likely to be exceeded by extreme events on a more regular basis (ibid). For instance, research on the Cairns area shows that flood risk from a one in a hundred year storm surge would more than double by 2050 (Henessey et al. 2007, p. 520).

Water is a particularly critical issue for Australian coastal amenity communities, whose water needs fluctuate greatly during times of peak tourist visitation. The key issues are: the sufficiency of water supply, particularly given likelihood of increased variability of rainfall patterns and drought in many areas (and the vulnerability of this supply to contamination from salt water intrusion or flood events, including risk to ground water supplies); the capacity of waste water systems (particularly the exposure of waste water treatment plants to flooding); and storm water management systems (given likely increases in rainfall intensity and flood events).

Table 2: Potential Climate change impacts and implications for sea change communities

Potential Climate Change Effects	Impacts for sea change communities
Sea level rise Coastal erosion	Loss of beaches Migration of sand dunes Loss of / threat to private property Infrastructure threat / damage Impact on lifestyle / amenity values Biodiversity loss Tourism values (especially iconic beaches)
Frequent storm events More intense storm events / cyclones Increased rainfall Decreased rain fall	Public safety and evacuation capacity Capacity of emergency services – volunteers, infrastructure (hospitals, shelters, supplies) Damage to infrastructure (energy, water, road, buildings, telecommunications, coastal ports, jetties) Water shortages (during drought) & contamination (storm events, inundation, flooding, ground water salination / disturbance) Agricultural industry impacts – sudden weather events (eg. cyclone) + long term events (eg. drought) Tourism impacts (damage to tourism infrastructure, visitor perception of risk) Damage to marine ecosystems from storm / agricultural runoff
Warming sea temperatures, ocean acidification	Damage to coral reefs Threats to marine habitat and species, coastal ecosystems (mangroves, saltmarshes, sea grass) Damage to estuaries – biodiversity, tourism and economic values Threat to fisheries & recreational fishing Threats to port functions
Increased temperatures Increased humidity	Public health, especially frail aged community Disease vectors (insects) Food spoilage Capacity of health services Economic impacts of disease Peak energy demand increases

Sources: IPCC 2007a, Henessy et al. 2007, Voice et al. 2007

Health

Climate hazards can impact on human health in many ways. Floods and storms are associated with injury; the spread of water borne diseases and diseases from insects and rodents; respiratory illnesses from dampness and mould in the home; and mental health impacts associated with the trauma of emergency, illness, displacement, or loss (Few 2007, p. 282). Other extreme events, including heatwaves, bushfires, and droughts are also associated with a range of respiratory, disease, and psychological health impacts.

These health impacts represent differential risks to different social groups, depending on their health status, perceptions of risk, and capacity to take measures to reduce exposure.

Older people, those with a disability, and children, are particularly vulnerable to the health impacts associated with climate change (Cutter and Finch 2007, Few 2007, Rosenkoetter et al. 2007). Coastal amenity communities, which have significantly older aged profiles than Australians overall and are aging at a faster rate, therefore face a significantly high risk of health impacts arising from climate change. Older people may be less able to comply with evacuation orders or to understand or afford to follow hazard reduction instructions (Rosenkeoetter et al. 2007). In coastal areas beyond the capital cities, older populations are particularly vulnerable as health services are limited and dispersed. Those in regional and rural coastal areas are also more likely to be cut off from these facilities during times of emergency.

Existing health services may be unable to cater to an increase in climate related population health issues, as health services in many coastal amenity areas are already insufficient.

Social impacts

Like the range of health impacts outlined above, coastal amenity communities have particular social vulnerabilities to climate change. Coastal amenity populations have lower income levels than Australians overall (Gurran et al. 2005, Gurran and Squires forthcoming). Recent disasters, such as the Katrina flood in the United States, show that lower income populations are at increased risk from the impacts of natural hazards and man made disasters (Masozera et al. 2007). This is because their housing is often less well maintained so they may be more at risk of injury and death if their dwelling is unable to provide adequate protection.

At particular risk are those in temporary housing like caravans and manufactured homes, which are an important source of housing for low income Australians and retirees, particularly along the coast. Also at enhanced risk are households in rental properties, as they have limited capacity to ensure their dwelling is fortified to withstand increased risk (Burby et al. 2007, Cutter and Finch 2007, Levine et al. 2007).

Populations characterised by high rates of resident turnover, are also associated with increased risk. New residents, particularly new residents in rented dwellings, are known to have fewer social ties with their new community in the early phases of settling in (Burbey et al. 2003). As their immediate priorities are about establishing a new home, it has been shown that they are less likely to have the resources or social connections needed to access assistance and information in times of a disaster (Levine et al. 2007). These groups are also most likely to relocate during the period following a disaster.

Table 3: Social vulnerability and climate change risk

Social characteristic	Risk
Low income	May be inadequately insured Limited capacity to afford adaptation actions to improve safety and thermal comfort of dwelling Higher impact of pricing mechanisms, less capacity to 'purchase green alternatives'
Rental tenure	Limited capacity to undertake adaptation actions to improve safety and thermal comfort of dwelling At greater risk of permanent displacement following a disaster
New arrivals / high population 'turnover'	Unfamiliar with disaster protocol / evacuation procedures Less time / capacity to adapt dwelling to disaster risk Less connected to social support networks
Caravan park residents	Dwelling type unable to withstand major storm events Dwellings often located in exposed positions, or on floodplains Low income caravan park residents at risk of permanent displacement as higher income evacuees require temporary emergency housing
Older population profile	Aged people more vulnerable to health and safety impacts of disease outbreaks, heatwaves, and storm events May be unable to comply with disaster protocol

Source: The Authors

Tenants, as compared to homeowners, may be more impacted (table 3) (Burby et al. 2007). Without proper insurance or ownership of land there is a high likelihood that tenants will face long term displacement. Landlords are less likely to rebuild their houses than owner occupiers. Even the immediate shock of a severe storm event places upward pressure on housing costs elsewhere in the market as many people search for new accommodation.

Policies designed to mitigate climate change impacts, such as pricing mechanisms intended to discourage energy or water use, may have a disproportionate impact on lower income groups who have less disposable incomes. Policies to adapt to climate change, such as stronger building codes may also



have an inequitable impact. Overall, it is important to analyze the potential differential impacts of policies on the variety of populations affected (Rogner et al. 2007).

Amenity

Amenity implications of climate change include damage to beaches, recreational areas, and landscapes or items of cultural significance (New Zealand Climate Change Office 2004). Increased temperatures may make some forms of outdoor recreation – bushwalking, cycling, or golf, less appealing, particularly during summer. Increased weather volatility may make boating and other water sports more dangerous.

Recreational diving activities may decrease due to increased storm activity or damage to marine ecosystems. Beach and cliff top trails and paths may be subject to more frequent damage and increased exposure to landslip. Insurance premiums for local authorities responsible for maintaining these areas will increase.

2.6 Legal liability of local government to consider climate change in strategic planning and development assessment

Local government may become legally liable for the ways in which decisions relating to potential climate change impacts are carried out (England 2006).

Already in Australia, the decisions of planning authorities have already been challenged for failing to consider climate change in assessing new development. In July 2005 a non government environmental group sued the Australian government for not acting to protect the Great Barrier Reef from climate change (Gupta et al. 2007). Similarly, in late 2007, the NSW Land and Environment Court issued a landmark ruling on the need for planning authorities to consider future flood risks associated with climate change (Walker v Minister for Planning [2007] NSWLEC 241). The Court found that the State Government had failed to consider the potential impact of climate change on future flood risk in approving a proposed residential subdivision and retirement village at Sandon Point in Wollongong (under Part 3A of the Environmental Planning and Assessment Act). The decision has particular importance for development in coastal areas. It means that planning authorities need to look beyond existing measures of flood risk (which are based on historic records) towards potential increased risks under future climate change scenarios.

Planning authorities in NSW may increasingly be obliged to consider the greenhouse gas impacts of mining projects (Freehills 2007). In 2007 a decision by the NSW State Government to approve a mine in the Hunter Valley (known as “Anvil Mine”) was overturned by the NSW Land and Environment Court which found that the planning authority had not followed the procedural requirements for environmental assessment by not considering the significant end user or down stream impacts of the proposal to extract coal (which would be burned offshore) (Gray v Minister for Planning [2006] NSWLEC 720).

These actions suggest that attention may shift from individual decisions relating to specific proposals, to the broader duty of care of government planning authorities in making new land use plans to prevent forms of development that are associated with high greenhouse gas emissions or increased climate change risk. Failing to exercise due care in approving new developments that may be at enhanced risk of natural hazards such as storm events, flooding or erosion may also become a legal issue for local governments in Australia.

The insurance industry is beginning to respond directly to these issues by not insuring areas at risk of inundation and/or storm surge (WWF and IAG 2008).

2.7 Conclusion

This chapter has outlined the range of potential impacts of climate change for coastal Australia, some of which are occurring already. We have emphasised the need to align mitigation and adaptation strategies to maintain and enhance the lifestyle attributes and amenity of coastal sea change communities, and noted that planning authorities may become legally liable in the future if they have



failed to take these matters into account when making plans and assessing developments. In the following chapter we turn to the range of leading practice principles and models for climate change adaptation and mitigation in coastal amenity areas.



3 Leading practice in planning for climate change in coastal amenity areas

This chapter draws on international literature and policy to outline leading practice in planning for climate change. The focus is on approaches suitable for the fragile coastal settings and volatile growth scenarios that characterise Australian coastal communities. Some of the approaches outlined here were discussed in relation to environmental approaches in our report on best practice local and regional planning for sea change communities (Gurran et al. 2006). In this chapter we explore these approaches further, emphasising their role in mitigating climate change contributions and improving community resilience to climate change impacts through adaptation strategies.

The first part of the chapter proposes principles of leading practice in planning for climate change within coastal amenity areas. The second section outlines criteria for considering climate change adaptation and mitigation in land use planning and development control. The final section outlines leading practice approaches and models across environmental, economic, community, infrastructure and governance sectors.

3.1 Principles for leading practice

As noted in chapter two, climate change impacts are occurring already. Planning decisions made every day result in settlement patterns, buildings and infrastructure that will be around for at least the next 50-70 years (Holper et al. 2006). Some of these decisions will increase the exposure of developments or the natural environment to climate change impacts now or in the future.

Planning regulations can establish the legal framework to ensure that decisions do not exacerbate climate change impacts or threat, but such regulations take a long time to modify. Action is needed today, to ensure that planning regulations prevent further damage to the environment and avoid further exposing populations and natural systems to risk associated with extreme weather events. Planning instruments also need to be reviewed in terms of 'enabling' innovative adaptation and mitigation responses to climate change.

Leading practice in planning for climate change is not inherently different for coastal amenity communities, but some strategies will have greater urgency in these settings than others. The following overarching principles for leading practice emerge from the literature on climate change mitigation and adaptation planning.

- Uphold the principles of ecologically sustainable development in designing adaptation and mitigation approaches, including environmental integrity, social equity and participation, economic viability and the precautionary principle. This is critical for coastal amenity communities whose populations include higher proportions of lower income and socially disadvantaged groups.
- Prioritise actions worth doing anyway, which for coastal amenity communities mean actions that have multiple benefits for the environment, for managing coastal processes, for the affordable and efficient provision of infrastructure, for nature based amenity and tourism and for more socially cohesive settlements.
- Use a sound evidence base, for identifying and justifying planning responses to climate change. Many smaller coastal councils will need assistance in accessing, interpreting, and applying consistent and reliable sources of scientific information about climate change scenarios.
- Plan now, to prevent further risks associated with climate change. Coastal amenity communities experiencing rapid population growth will experience pressure for rapid development approval, before climate change considerations have been factored into planning and assessment frameworks.



The principles of sustainable development must govern responses to climate change (IPCC 2007a, 2007b). For instance, actions designed to adapt to climate change should not increase harming pollutants or greenhouse gas emissions, although the IPCC acknowledges that trade offs may sometimes be reached. Disturbance of natural systems should also be avoided where possible. Rather, adaptation actions should seek to protect and restore biological diversity, prioritising actions that enhance climate change resilience by restoring natural systems, and where possible avoiding adaptation actions that undermine natural processes. The precautionary principle¹ (first, do no harm) is particularly important when considering the impact of adaptation options on natural systems.

In line with ecologically sustainable development, the principle of equity is an important consideration in decisions about climate change adaptation and mitigation (Rogner et al. 2007). The costs of mitigation efforts should be borne fairly across the population without disadvantaging one sector more than others. Similarly, the costs of adaptation actions should be spread across a population with consideration given to income and circumstances when introducing strategies to protect communities and individuals from climate change impacts. Equity also demands that communities have an opportunity to participate in decisions that will affect them.

Economic considerations are also important. Planning frameworks should seek to support emerging green businesses without undermining the existing economic base of a community. The ideal is to develop strategies for long term transition to climate change resilient industries. Decisions about adaptation actions should recognise their full economic costs and benefits.

A sound evidence base is critical to identifying and justifying appropriate strategic planning responses to climate change. This information base needs to be continually updated to reflect changes in climate change forecasting and with respect to developments in building and infrastructure technology. As these enhancements are realised, it is important to amend planning regulations to support and require compliance with higher environmental standards. Similarly, as information about actual or potential climate risk changes, planning standards must be amended to reflect these new scenarios. Interventions commenced today should be flexible enough to adapt as circumstances change or new information becomes available.

Many actions associated with climate change are worth doing anyway – these strategies should be prioritised as they will have multiple benefits. A matrix to assist in identifying strategies that meet more than one objective for coastal amenity communities is presented in chapter five. Finally, it is important to ‘mainstream’ considerations about climate change mitigation and adaptation so that they are evaluated alongside other important strategic planning matters when land use plans are being prepared and when specific proposals are being assessed. We turn to the issue of mainstreaming in the next section.

3.2 Land use planning for climate change mitigation and adaptation

A strong strategic planning and development assessment framework ensures that climate change is a mainstream or standard consideration during plan making and environmental assessment processes. The carbon impact of future land use or development forms must be an explicit consideration in all strategic land use planning and development assessment processes. Strategic, legally enforceable plans need clear objectives for the reduction of greenhouse gas emissions and unambiguous targets or requirements for assessing the carbon performance of individual development proposals.

Such requirements are best situated within a planning framework that establishes incentives to encourage and reward effective carbon performance development and disincentives that discourage developments associated with poor carbon performance. At the national, state or territorial level, high

¹ The precautionary principle is defined generally as: If an action or policy might cause severe or irreversible harm to the public or the environment, in the absence of a scientific consensus that harm would not ensue, the burden of proof falls on those who would advocate taking the action. See Raffensberger, C., J Tickner, eds. 1999. *Protecting Public Health and the Environment: Implementing the Precautionary Principle*. Washington D.C.: Island Press.



level planning policy to 'mainstream' climate change mitigation and adaptation considerations in all coastal planning decisions is needed.

Given the rapid speed at which climate science and technology shifts, compared to the slower time frame needed to amend planning regulations, at the local level it may be prudent to establish graduated planning requirements that can adjust to policy change or technological advances – for instance, targets for energy efficiency that increase over time. It is also wise to encourage flexible solutions that can be adapted over time, in ways that increase resiliency.

Plan making

When undertaking strategic land use allocation planning processes, the following specific considerations must be taken into account:

- The existing and potential exposure of particular locations / infrastructure to risks associated with climate change and the potential to reduce this vulnerability through specific building standards, development controls, or direct works;
- The potential impact of the settlement or infrastructure, including the location and configuration of development, on the vulnerability of existing settlements, natural habitat or biodiversity, including 'downstream' impacts;
- The location of existing and planned settlements / developments in relation to access routes, services, and infrastructure, and the likelihood of continued access to these facilities in the event of an emergency; and,
- The ability to service locations with alternative transportation, including public transit, walking, and biking, and the general contribution of the location to reductions in auto trip numbers and length, to ensure that the location works toward climate change mitigation.

A formal climate change vulnerability assessment can be undertaken to support strategic land use planning decisions, and could even become a requirement to accompany applications that require major rezoning or other substantial changes to planning controls.

Development control

Consistent with the proposed strategic planning framework above, development assessment frameworks should require the following matters to be taken into account when proposals are considered:

- The scale and duration of the impact, both of the primary development itself (and associated construction), and potentially, any 'downstream' impacts. The assessment must also consider ways to avoid, negate, or offset the impact of the development on greenhouse gas emissions and any existing or potential legal duty of care to consider direct or indirect carbon impacts of the development;
- The vulnerability of the particular site and proposed development to existing or potential threats associated with climate volatility or long term change, and implications of the proposal for the vulnerability of surrounding areas;
- The potential to reduce risks and the potential to further adapt the development / activity if climate impacts accelerate or increase;
- The importance of the proposal for the community and whether the developer will bear the costs of any risk mitigation infrastructure work associated with it;
- Ways to monitor the impact of the development over time and to introduce new mitigating technologies when and if they become feasible; and,
- The ability to service the site and proposed development with alternative transportation, including public transit, walking, and biking, and the general contribution of the development to reductions in auto trip numbers and length.



These matters may be routinely considered for locations and proposals associated with minor increased risks. However, they are likely to have particular resonance for significant coastal developments. It may be prudent for local plans to require a specific climate change vulnerability assessment to accompany development within identified areas or development of a certain threshold type or scale.

Information sources

Unlike other nations (such as New Zealand and the United Kingdom), regionalised or local information about current climate change predictions is not yet available on a national basis. Developing such an information resource is a critical priority. In the mean time, reliable sources of information about climate risk for Australian coastal amenity councils include the CSIRO, the Commonwealth Department of Climate Change, state government departments for planning or the environment; and council commissioned research. In some cases planning authorities may need to require developers to submit their own studies or to pay for a study to be commissioned by council.

Planning frameworks governing adaptation and mitigation decisions must be able to be reviewed as information changes or new technology becomes available. Graduated threshold indicators tagged to environmental changes (such as observed sea level rise) might offer one approach. These thresholds can be 'built in' to the planning framework to promote certainty for landholders and developers, to allow rapid responses to change, and avoid the administrative burdens associated with frequent plan revision. A graduated approach to managing climate risk tagged to threshold indicators of change also means that prudent action can be undertaken immediately to protect communities from further vulnerability, despite existing knowledge gaps. At the same time, a graduated approach that responds to changed circumstances or information avoids introducing unnecessarily restrictive policies that may unfairly constrain development.

The following sections describes more detailed principles and leading practice approaches in responding to climate change within Australian coastal amenity communities, across environmental, community wellbeing, economy, infrastructure and governance sectors. Some approaches appear across more than one sector, an indication that it achieves multiple objectives.

3.3 Addressing environmental implications of climate change for coastal amenity communities

Australia's coastal amenity communities are defined by the quality of their natural environments. Many of Australia's listed world heritage sites and outstanding protected areas are situated in coastal areas, and many other important landscapes, ecosystems and natural features are located beyond formal reserve boundaries. These environmental assets – beaches, headlands, rainforests, mangroves, lagoons or estuaries -- underpin the appeal of coastal amenity areas, attracting new residents as well as visitors to the area. Coastal communities depend on their natural environment for a variety of ecosystem services too – from clean water to climatic comfort (shade and protection from extreme wind and storm surges) and a viable aquaculture and fisheries sector.

It is critical to ensure that planning frameworks provide adequate protection for the natural environment from impacts of climate change, by preventing forms of development that would further compromise natural systems and by encouraging development or interventions that will enhance the resilience of the natural environment to adapt to potential climate change impacts.

Plan to enhance the resilience of coastal processes and features by:

- Identifying existing pressures to natural landscapes, habitat, catchment values and biodiversity as well as potential threats relating to climate change and placing areas of important vegetation and coastal habitat within an environmental protection zone or equivalent, if not already protected. Regional coastal settlement plans taking a more integrated approach to future development will be critical.



- Using coastal setback areas as opportunities to reintroduce and restore local biodiversity and creating planning system incentives and requirements for new developments to retain and restore local biodiversity.

Plan to enhance the resilience of coastal processes and features by:

- Identifying low lying and exposed areas, and assessing the potential to reintroduce natural 'soft' defence measures through direct works or as a planning requirement when frontal coastal areas are developed.
- Ensuring that planning regulations prohibit development that may exacerbate the vulnerability of coastal processes through changed hydrological patterns, migration of dunal systems, filling or dredging of wetlands or mangroves. Provide for consultation with expert agencies for development in particularly vulnerable areas or for development of a certain scale.
- Introducing special environmental assessment requirements for areas where existing information is insufficient to determine the impact of potential development scenarios without additional and costly research. Such research may have become available at the time an application is lodged or might be funded by the developer.

Plan to enhance the resilience of coastal amenity communities to natural hazards by:

- Identifying a range of sea level / natural hazard thresholds or indicators as a basis for setting coastline building setbacks and requirements for removal / retreat of buildings. A graduated approach responding to changes in these thresholds allows for flexibility.
- Reviewing existing natural hazard requirements – eg. relating to flooding, cyclones, or bushfires, bearing in mind likely increases in the intensity or frequency of major events. Consider reorienting natural hazard assessment methodologies contained in plans from historical events to the range of forecasted impacts associated with climate change scenarios.
- Revise land use designations and permitted building forms in the light of this natural hazard assessment. As well as the location of housing or other built infrastructure within revised potential hazard areas, consider the availability of access ways and congregation spaces for emergency evacuation.
- Establish mechanisms to re-situate land uses that may become unsafe or unsuitable in the future due to climate change. These range from public infrastructure – like water treatments systems or land fill sites, which may pose significant risks to public health and, in the event of a coastal flood, to private property at risk of inundation or landslip. A system of 'transferable development rights', used within an appropriate 'receiving area' may provide a prudent long term option for relocating land uses from areas that face unacceptable levels of risk.



Box Two: Examples / Resources (Environment)

Alexandrina Local Government Area in South Australia, contains several nationally significant biodiversity areas that are likely to be threatened by climate change impacts, including the Coorong, Lakes Alexandrina and Albert Wetland, and the Swamps of the Fleurieu Peninsula. The Council completed a new sustainability action plan “Sustainable Alexandrina Action Plan 2007-2010”, which contains a number of actions relating to climate change and biodiversity protection, including conservation of biodiversity corridors and remnant vegetation. The plan recognises current threats to wildlife populations and vegetation as well as potential threats to these assets arising from climate change (see http://www.alexandrina.sa.gov.au/webdata/resources/files/SAAP_2007-10.pdf).

Byron Shire in NSW has adopted specific climate change parameters for temperature increases, sea level rises, rainfall intensities, cyclone intensities and storm surges. Its Strategic Planning and Climate Change report to council (November 2007, see <http://www.byron.nsw.gov.au/Meetings/Meeting.aspx?Id=62>) outlines a 100 year planning period for proposals or issues that may be affected by climate change, and undertakes to incorporate climate change planning scenarios into all relevant plans and responsibilities (including infrastructure, land use planning, and development assessment). The report acknowledges that these scenarios might change following subsequent IPCC information or recommendations from CSIRO or the NSW Department of Environment and Climate Change.

Clarence City Council in Tasmania has commissioned detailed research on the potential impacts of sea level rise on foreshore areas (<http://www.lgat.tas.gov.au/site/page.cfm?u=542#CCC>). The report, completed in August 2007, establishes a vulnerability assessment methodology for small coastal communities (SGS 2007). It provides information on community attitudes towards climate change and the range of potential adaptation options – from protection to accommodation and retreat.

NSW Government flood management guidelines outline useful criteria for assessing the potential vulnerability of a site to flood risk, in the context of potential increased risks associated with climate change. The guideline is a useful reference in assessing changes in exposure to natural hazards more generally (DECC Floodplain Risk Management Guideline: Practical consideration of Climate Change).

3.4 Planning for climate resilient economies in coastal amenity areas

Coastal amenity communities are already experiencing many economic challenges and potential threats associated with climate change add to these. Many of the planning actions needed to protect agricultural industries or tourism assets from climate change effects are strategies that should be undertaken anyway. Overall, strategic planning processes must identify sectors of the economy that are at risk from climate change impacts, and establish strategies to reduce this risk while encouraging future economic growth that will be resilient under predicted conditions of change.

Regional and Local plans should:

- Ensure that future employment and industrial lands are situated in areas of low climate risk.
- Strengthen design or development controls requirements for industry to withstand natural hazards and for thermal comfort.



- Assess new proposals to ensure resilience to the impacts of climate change.
- Identify opportunities to capitalise on carbon friendly industries – from green technology to renewable energy production or carbon sequestration.

Plan to maintain and enhance tourism appeal, and strengthen resilience to climate change impacts by:

- Ensuring that areas for new tourism development are situated in locations that are not at long term risk of climate change impacts and revising construction, safety and emergency standards for visitor facilities and tourism infrastructure, including landscaping requirements.
- Identifying major tourism attractions and significant contributing landscapes or natural features, and ensuring that these assets are appropriately protected through planning requirements. Recognising and protecting scenic integrity may also have the benefit of buffering natural attractions to increase their resilience.
- Improving the climatic comfort of key destinations through planning policies requiring shading, urban vegetation, building configuration to take advantage of ventilation and breezes, and climate sensitive building forms.
- Appealing to eco tourism markets, by featuring climate friendly design requirements for new tourism developments, including renewable energy and energy saving design requirements, on site water retention, recycling, and demand reduction strategies, and best practice waste reduction, recovery, and treatment approaches.

Plan to preserve and enhance viable local and regional agricultural production in coastal amenity communities by:

- Preserving existing agricultural lands through planning controls and incentives to support viable agricultural production, while permitting compatible economic activities to coexist in agricultural areas.
- Enabling multi function use of agricultural lands, provided that additional uses do not threaten the long term quality of the land for agricultural production. Examples of additional uses include decentralised energy or power plants such as wind or solar farms.
- Consider evaluating different forms of agriculture based on the likely repercussions of storm events, so that agricultural operations that would contribute to problematic outcomes are regulated or placed into low risk areas.

Plan to maximise new opportunities arising from changed climatic conditions and or climate change technology for settlement design and operation by:

- Identifying sites or precincts where climate technology can be developed or demonstrated, and ensure that zoning or development controls support these activities – tourism resorts, science or business parks might all be encouraged to demonstrate renewable energy forms, onsite waste recovery, water harvesting and recycling.



- Identifying opportunities for climate change adaptation approaches – such as wetland protection or reconstruction, or increased coastal setback and re-vegetation works – to support existing and potential economic activities relating to leisure or tourism.

Box 3: Examples / resources (Economy)

Byron Shire in NSW has established a Sustainable Agriculture Strategy, which includes strategies for more environmentally sustainable agricultural production and food consumption which will become increasingly important in the context of climate change. It is supported by a 'food mile' program to raise awareness of the environmental impacts of transporting food and to promote consumption of local produce (see <http://www.byron.nsw.gov.au/Sustainability/Agriculture/>).

Thuringowa in Queensland is developing a Sustainable Village Project to demonstrate excellence in climate responsive design, alternative design approaches, products and materials. The project is being developed at rates that are comparable to current market housing costs to demonstrate the viability of more sustainable forms of urban development (see http://previous.thuringowa.qld.gov.au/council/departments/planning/sustainable_village/news).

Wollongong City Council in NSW is the site of Australia's first wave power plant. The commercial power station (which floats offshore) was established to power 500 homes through the local grid, and can also desalinate 2,000 liters of drinking water each day. The company responsible for the power plant, Energetech, has plans to roll out another 10 plants near Portland in Victoria (Reuters 3/32007; see <http://www.environment.gov.au/settlements/renewable/recp/wave/pubs/wave1.pdf>).

Miami – Dade County in Florida has undertaken research to estimate the economic costs and opportunities associated with climate change, including impacts of lost tourism. The County is explicitly promoting growth opportunities based on renewable energy technology, capitalising on sources like wind, solar, and wave power (<http://www.sfrpc.org/data/ClimateChange/Economy%20Fact%20Sheet.pdf>).

3.5 Planning for climate resilient populations in coastal amenity communities

As noted in the preceding chapters, coastal amenity communities already face a number of social challenges. High proportions of non resident ratepayers, a constant influx of new residents (who may also move on again within a short period of time), and seasonal visitation by tourists, undermine community cohesion in many coastal areas. This instability also increases community vulnerability during times of emergency – where strong social networks and support systems are needed to communicate information about dangers and to assist in times of emergency. The elderly, low income, renters, and residents of mobile home parks and similar vulnerable constructions, will need the most policy attention to assure overall community safety (Cutter and Rich 2007).

Community wellbeing in coastal amenity communities is tied to appreciation of their unique lifestyle and the ability to enjoy the natural environment. When important attributes are threatened by climate change impacts – such as shoreline erosion leading to the loss of local beaches, land slip reducing opportunities for coastal walks, or increased numbers of uncomfortably hot days, amenity communities are at real risk of losing their fundamental appeal, for residents and visitors alike.

Emergency planning can be conceptualised in three stages – pre emergency, when the goal is to reduce the risk; immediately post emergency, when the goal is to respond to basic health and safety needs such as shelter and clean water; and longer term, when the goal is to reestablish a community (Levine et al. 2007). In the third phase the policy opportunity is to reestablish a settlement that is more



resilient to future disasters and that provides other social or economic benefits by way of superior planned design. Unfortunately however, in practice it is likely that the pressure to for rapid resettlement leads to inferior outcomes – often the rapid construction of low density car dependent suburbs. Planning ahead for the third phase – before a disaster strikes – provides an opportunity to do things better next time (Handmer and Dovers 2007).

Plan to minimise potential health risks associated with climate change by:

- Ensuring that housing is located in areas of low risk from natural hazards and able to be easily accessed by emergency services.
- Ensuring that design standards applying to manufactured home estates and caravan parks afford suitable protection for extreme storm or hurricane events. Siting must enable safe and easy evacuation for residents.
- Tailoring urban design guidelines and building codes for public and private buildings to ensure that in case of a power outage during severe heat, residents can open windows or otherwise cool their homes and workplaces. Generally encourage appropriate design that maximises cross-breezes and natural building interior cooling.
- Tailoring urban design guidelines and building codes for public and private buildings to minimise urban heat island effects arising from hotter temperatures and heatwaves. This may include encouraging more trees, 'green' (planted) roofs, attention to building and paving colors, and similar actions. It may also mean moving towards designing 'green precincts', not just individual buildings.
- Design public space to address more severe local climatic conditions and to reduce urban heat island effects. Require shading, shelter, and appropriate vegetation to cool areas of open space and walkways or cycle paths, and consider ways to design public amenities for safety and storage during storm events.
- Consider the impact of planning requirements (such as those relating to water sensitive urban design) and the placement of infrastructure on the potential for the spread of water borne and vector borne diseases.

Coastal amenity communities can strengthen their capacity to withstand and recover from natural emergencies by:

- Maintaining spaces for emergency access, congregation, shelter and evacuation.
- Planning ahead for evacuation, including public transit evacuation of non-car owning public (especially the elderly, the frail and the young). Special communication strategies may be needed for these vulnerable groups (Cutter and Rich 2007).
- Identifying and reserving locations for intermediate post emergency recovery (these locations should be resilient to natural hazards but may be multi-function). Actively planning ahead for settlement reorientation or design following a major natural disaster, and ensuring that land use decisions do not compromise these future intentions.
- Ensuring that water, energy and communication services and infrastructure are likely to withstand most emergency situations and / or promoting smaller and more decentralised sources of water and power.



Box 4: Examples / resources (Community)

The **Gold Coast City Council** is participating in an innovative study of the health impacts of climate change for coastal cities, in conjunction with the Australian Greenhouse Office (<http://www.greenhouse.gov.au/impacts/settlements.html>). The Gold Coast is one of several councils in Queensland to specify standards for climate comfortable building designs, solar access, cooling breezes, and shading for public spaces within the local planning scheme.

Councils in the **Hunter and Lower North Coast regions** collaborated with regional and state organisations to develop a regional mosquito management strategy ("Living with Mosquitoes in the Hunter and Lower North Coast Region", Webb et al. 2005). The agencies involved included Newcastle City Council, Port Stephens Council, Lake Macquarie Council, Great Lakes Council and Maitland Council; the Hunter-Central Rivers Catchment Authority, NSW Fisheries, and the Hunter New England Health and Department of Environment and Conservation. The goal of the strategy is to "better understand and communicate the issues surrounding mosquitoes and their management to a range of stakeholders, including politicians, the wider community, the media, planners, educators, government authorities and natural resource managers" (p. 7).

The strategy contains a wealth of information concerning planning and design approaches to minimise mosquito breeding and is available at:

<http://www1.hnehealth.nsw.gov.au/hnep/LivingWithMosquitoes/LivingWithMosquitoes.htm>

The **Victorian Government** has produced an assessment of the health impacts of climate change for Victoria (released in October 2007) http://www.health.vic.gov.au/environment/downloads/cc&h-challenges_public_health_vic.pdf). The document is a comprehensive source of information about the range of health impacts associated with climate change, including sea level rise, and scopes the public health measures, including public information, prevention, and emergency response strategies needed to adapt to climate change. The document emphasises the positive health benefits that might arise from climate change mitigation strategies, such as promoting walking and cycling rather than driving, which encourages more active lifestyles and reduces the incidence of cardiovascular diseases and diabetes (Victorian Department of Human Services 2007, p. 28). It also suggests that community health benefits and social capital may arise from efforts to reduce the social isolation of people vulnerable to extreme weather events such as heatwaves.

While not a coastal amenity council, the **Greater London Authority** promotes several innovative approaches to planning for heat waves, including requiring public buildings to have publicly accessible "cool spaces". Such strategies address the differential impacts of climate change impacts on poorer households whose dwellings may be unsuited to temperature extremes (London Climate Change Partnership 2006, see <http://www.london.gov.uk/climatechangepartnership/adapting-jul06.jsp>).

3.6 Planning for climate resilient infrastructure in coastal amenity areas

Infrastructure in many Australian coastal amenity communities is already under considerable pressure. Earlier work for the National Sea Change Taskforce (Gurran et al. 2005) documents infrastructure shortfalls for existing and future population and visitor needs (roads, sewer, water services, public transport) and insufficient capacity to finance these shortfalls through existing sources (grants, rates, and developer contributions). At the same time, coastal amenity communities continue to experience strong pressure from new residents for services and infrastructure on par with that of the major cities.



Climate change represents several additional challenges for infrastructure provision in coastal areas. Areas with high seasonal visitation experience periods of peak demand for water and energy. However, many communities already experience severe water shortages during summer, coinciding with the visitor season and when the impacts of drought are likely to be the most intense. Similarly, peak energy demands during hot weather are likely to cause power failure during summer holidays when tourism visitation is highest.

At the same time, large scale forms of new infrastructure, associated with expensive maintenance, long life cycles, and major environmental impact, might not be an appropriate response for many coastal amenity communities, particularly given medium and long term uncertainty over climate change impacts. The international trend is towards smaller forms of decentralised water, energy, communications and waste management infrastructure, which are associated with fewer greenhouse gas emissions and greater overall regional resilience during times of emergency (Bulkeley and Betsill 2003, ODPM 2004). These approaches combine climate change mitigation and adaptation goals.

Transport and accessibility are already major issues for Australian coastal amenity communities. By their nature dispersed along the coastline, the private motor car is the main form of transport between and within settlements. As increased temperatures and sudden storm events will place more pressure on road infrastructure, increasing risks from sudden flooding and landslip, the availability of all weather access roads should become an overriding consideration when planning for the location of new settlements or the extension of existing ones.

Other forms of transportation, linking coastal amenity communities, including island communities, with other areas, may also be affected by climate change impacts, but they may also become increasingly important. The exposure of ports and marinas to major storm surges will need to be appraised regularly and the impact of new port areas, port expansions, and marinas carefully assessed. Airports, providing safe emergency landing areas may become critical during times of disaster. Air travel, however, is extremely energy inefficient, and thus alternative travel modes may become more important as regions and travellers seek to reduce their carbon footprints. Heavy rail and new rapid rail may again become important, as climate resilient and carbon neutral forms of infrastructure and transportation to link regional and coastal communities to major centres.

Mixed use areas and reduced need for motorised transport within coastal amenity communities can enhance retail areas, which benefit from increased concentrations of activities. Tourist facilities and associated industries often benefit too from locations that allow visitors to walk or cycle to major attractions, restaurant and retail precincts. These opportunities help create a complete 'destination' experience, while also reducing problems associated with traffic congestion.

However, hot summers, with increased temperatures, may discourage people from walking or cycling and reinforce preferences for air conditioned private vehicles. Strategies to ensure that walkways are shaded and cooled by natural vegetation and cross breezes are critical to ensure that walking and cycling become increasingly important elements of quality of life and visitor experience within coastal amenity communities. Such strategies also support policies to mitigate greenhouse gas emissions.

Public transport strategies are needed to connect coastal settlements to regional facilities and to provide all weather transport within settlements for residents and visitors. Increased patronage by tourists may also mean that public transport options become more financially viable. It will be very difficult for Australian cities (and those in other developed countries) to reach their climate mitigation/greenhouse gas reduction goals without addressing the role of private automobile transportation in greenhouse gas emissions.

Plan to strengthen the resilience of community infrastructure to climate change impacts by:

- Assessing the location of existing and planned infrastructure (roads, utilities, recreation centres, swimming pools, hospitals, schools, libraries and community centres etc), and vulnerability climate change impacts.



Identifying future locations for relocation of major infrastructure or establishment of new, decentralised energy, water, or waste management plants to service existing or planned development. Ensure that land use plans reserve these sites or indicate the need to include them within new release or redevelopment areas. Retrofitting existing urban centres to accommodate renewable energy options including cogeneration possibilities.

- Reviewing the design standards for public buildings and infrastructure items and private buildings (houses, apartments, commercial and industrial buildings etc) to minimise risk in case of more extreme weather events as well as more cumulative impacts of climate change, such as increased temperatures or drought.
- Revising infrastructure capacity plans to take future climate scenarios into account (for instance, likelihood of drought), rather than historical weather events, and adjust settlement thresholds accordingly (for instance, thresholds based on availability of water supply).
- Maximising multifunction opportunities, by prioritising the introduction of new infrastructure that delivers multiple environmental services as well as serving basic settlement needs wherever possible. For instance, wastewater management strategies that utilise natural or constructed wetlands, and may also provide recreational opportunities and contribute to biodiversity and landscape. These strategies have multiple quality of life benefits for amenity communities.
- Similarly, include clear land use planning objectives for new infrastructure forms to have minimal or no net carbon impact. Where such infrastructure is to be provided by private developers, include planning based incentives to support this provision (for instance, increased development potential on the site, or the elimination of other infrastructure levies).
- Emphasise potential for major developments to self provide basic infrastructure services – like energy, water, waste management, through strategies such as micro energy generation, water retention, demand reduction technologies, reuse, and recycling; and waste minimisation, reuse, and disposal. If technology is not currently available, ensure future opportunities are retained to introduce more carbon friendly and climate resilient forms of infrastructure in the future.

Plan for water security in coastal amenity communities by:

- Protecting the integrity of existing water supply by prioritising catchment protection in land use and development planning decisions, by adopting the principles of water sensitive urban design, and by considering other local or regional catchment management plans when decisions are made.
- Prioritising water supply options that are associated with minimal contributions to climate change impacts, so that major forms of intervention like desalination plants (associated with increased energy requirements and some increase in sea temperatures) are considered only if alternative technologies and strategies (including slower growth in certain areas) are not viable.
- Implementing water demand management strategies and requirements for new urban developments, particularly developments associated with major water needs, such as tourist facilities. Requirements might include mandatory use of water savings devices, planting of native species, water capture, recycling, and onsite water treatment (depending on other state government requirements and health standards). Increased rate payments or a special levies on tourism / visitor infrastructure might be required to offset the water impacts of tourist facilities during peak seasons.
- Maintain spaces for floods and water retention in regions where rainfall patterns are likely to become more volatile, characterised by fewer overall rainy periods, interspersed by sudden intense rainfall.



Plan to make transportation improvements a central component of mitigation as well as more resilient to climate change within coastal amenity communities by:

- Designing new settlements and reconfiguring existing settlements to reduce the need for trip generation and to maximise potential viability of public transport.
- Assessing the transportation impacts of all major new developments.
- Ensuring that new settlements are accessible by all weather roads or alternative routes.
- Prioritising attractive and well shaded walkways and cycle paths within existing and planned areas, linking residential, retail, and recreational precincts.

Plan to capitalise on opportunities for renewable and low carbon energy generation, and to increase resilience to climate change impacts for energy requirements by:

- Identifying and reserving sites or locations that may become suitable for renewable energy plants either now or in the future. Drafting renewable friendly energy planning and building codes, that enable broader environmental benefits to be assessed alongside local impacts on landscape, amenity, and economy.
- Creating planning incentives or requirements for major new developments to utilise local sources of renewable energy as much as possible, or provide offset payments to stimulate investment in local energy generation if technology is not currently available. Reviewing current pricing policy for renewable energy will be critical in making it cost effective to invest in urban renewable energy options.
- Protect solar access to ensure that developments retain capacity for onsite solar energy generation.
- Enforcing building and urban design requirements that minimise energy requirements and maximise thermal comfort.

Plan for carbon neutral and climate resilient waste management in coastal communities by:

- Auditing the location of existing and future landfill sites, and assessing the vulnerability of these sites to major weather events.
- Establishing provisions for composting at site and or neighbourhood level, to reduce waste in land fill and to assist in reducing the water requirements of local gardens. Require major developments to include a sustainable waste strategy as a condition of planning approval – or a special contribution to local waste management and recovery fund.
- In some cases, reserving larger local sites to accommodate waste sorting, recycling and reuse. Minimise the amount of waste in landfill sites, while exploring sustainable ways to harness the energy it represents, such as methane recovery and biomass plants.



Box 5: Examples / resources (Infrastructure)

Townsville City Council in Queensland is part of a consortium involving the Queensland Government, and private industry in establishing Queensland's first solar city project. The project will draw on funding from the Federal Government to demonstrate the economic and environmental benefits of solar power and energy efficiency technologies. The city has experienced sustained population growth however energy supply is a potentially limiting factor. The city has over 300 days of sunshine per year. It is ideally placed to explore opportunities to develop a significant solar energy project in two new Greenfield sites, known as the 'Solar Precinct' and the 'Riverway Project' (<http://www.soe-townsville.org/solarcities/index.html#about>).

The cities of **Boulder** and **Aspen** in Colorado, United States, have both developed energy codes to support the use of renewable energy sources. The City of Boulder has an energy code that guarantees solar energy access for home owners and renters. In addition to standard provisions for protecting solar amenity (a hypothetical 'solar fence' to protect four hours solar access during mid winter), a 'solar access permit' may be obtained by those who have installed a solar energy device and are concerned to guarantee ongoing access (see http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=207&Itemid=2173).

The City of Aspen has high energy standards in its local plan. For those unable to achieve a renewable energy system, payment of a 'mitigation fee' is able to be made. The fees have established a Renewable Energy Mitigation Program, which is used to leverage private investment in renewable energy and also to support renewable energy use and technology in public buildings (<http://www.aspenpitkin.com/pdfs/depts/71/Pitkinco11tx.pdf>).

The **Australian Green Infrastructure Council** was established in February 2008. The Council aims to develop a sustainability rating tool for industry projects by mid 2008. This could provide a helpful resource for local councils seeking to ensure new infrastructure projects meet sustainability criteria including climate change mitigation and adaptation considerations. The Council is supported by industry groups (including Engineers Australia's Society for Sustainability and Environmental Engineering) (see <http://www.agic.net.au/overview.asp>)



3.7 Effective coastal planning and urban governance responses to climate change

While local governments may lead their communities in responding to climate change, they do not act in isolation, but depend on collaboration across public, private and voluntary sectors (Hyden 1998). This collaboration to develop and enforce standards of behaviour between the government and non-profit and public interest organisations as well as the public is termed 'governance.' Strong governance arrangements are critical to developing an effective response to climate change. Unfortunately, the complicated layers of legislation and policy, and overlapping Commonwealth, state and local responsibilities for aspects of the coastal zone, represent a major challenge for effective governance within Australian coastal amenity communities.

Public involvement in decisions about climate change actions is also critical (Atkinson et al. 2007). Local stakeholders include local residents and businesses, traditional indigenous owners, the insurance, property development and real estate industries, fishing and agricultural industries and their consumers, tourist operators and visitors, environmental organisations and recreational groups.

Strengthen local government capacity to address climate change by:

- 'Mainstreaming' climate change considerations as part of all planning and management decisions. An important way to achieve this is by adopting strong objectives relating to climate change mitigation and adaptation within statutory land use plans, as well as criteria to evaluate the ways in which specific proposals meet climate mitigation and adaptation goals, as outlined above.
- Collaborating with other local governments at regional or sub regional level, in undertaking research about future climate scenarios and potential responses, using the Integrated Coastal Zone Management framework, where such processes exist, and enhancing this framework to address the broader social, and economic challenges affecting coastal communities in the context of climate change.
- Establishing effective and ongoing public involvement processes for information and deliberation on the identification and prioritisation of climate mitigation and adaptation responses.



Box 6: Examples / resources (Governance)

Kiama Council in NSW commissioned CSIRO to undertake an assessment of potential climate change impacts for the local area (completed in 2005), in response to the lack of sufficiently detailed information on which to base its future planning. The report includes local information on overall climate projections (temperature, rainfall, evaporation and moisture balance, winds) and climate extremes. It outlines the impacts of these changes for agriculture, water resources, biodiversity, fire risk, the coastline, and the Kiama community. The report was commissioned as part of the Council's review of their local planning scheme and also provides a helpful source of information for councilors, local residents, and businesses (see <http://www.kiama.nsw.gov.au/Environmental-Services/pdf/Climate-Change-report.pdf>).

Onkaparinga in South Australia has released a series of discussion papers outlining a range of potential issues for the local community to consider in developing a new strategic direction for the year 2020. As well as a paper specifically on understanding and developing responses to climate change, other key discussion papers, including the paper "Renewing the Economy", also focuses on climate change as an explicit challenge and opportunity for the local economy: "Reducing our environmental and carbon footprint is no longer just an environmental objective—it can serve as a source of competitive advantage as we move towards carbon trading and a global trading system which regulates environmental performance" (p. 20). (see <http://www.onkaparingacity.com/web/binaries?img=9549&stypen=html>; Strategic Directions 2020: Addressing Climate Change Discussion Paper 2 at: [http://www.onkaparingacity.com/OurCityCouncil/Strategic Directions](http://www.onkaparingacity.com/OurCityCouncil/Strategic%20Directions)).

The Victorian Government is sponsoring collaboration between coastal councils around climate change planning, under its **Greenhouse Regional Partnerships Program**. For instance, the **Western Coast Greenhouse Alliance** combines the local government areas of **Casey, Bass Coast, Cardinia, Frankston, and Mornington Peninsula** in sponsoring research and developing adaptation and mitigation responses to climate change at the regional level. Similarly, the **South West Sustainability Partnership** includes the local government areas of **Moyness, Warnambool and Glenelg** as well as regional agencies and TAFE. The partnership is working on a variety of demonstration initiatives including a pilot energy efficiency program for local business, carbon sequestration, and sustainable transport (see <http://www.climatechange.vic.gov.au/Greenhouse/wcmn302.nsf/childdocs/-8E003D664769BC69CA25702D00155403-D7AAC3D56A443B27CA2571A800123A57?open>).

The city of **Keene** in New Hampshire in the United States is a small town rich in natural amenity but with limited local government resources. Under the ICLEI Climate Resilient Communities Program, Keene trialed a methodology for undertaking an assessment of climate change vulnerability and responses, that can be managed by local government without the need for technical assistance. Identified areas of vulnerability and adaptation responses are then prioritised in a democratic way with members of the local community (see [http://www.ci.keene.nh.us/planning/Keene%20Summary ICLEI FINAL.pdf](http://www.ci.keene.nh.us/planning/Keene%20Summary%20ICLEI%20FINAL.pdf)).

Local authorities in the **Pueget Sound** region of in the Pacific Northwest of America have pooled their resources to undertake a quantitative sensitivity analysis of climate change impacts. Within this region, King County has developed an internal assessment process to scrutinise the likely impact of climate change within the local area, as well as potential climate change adaptation approaches. The County has formally resolved to address climate change and prepare for its impacts and confirmed this resolution through a local ordinance (the King County Council Ordinance on Global Warming, October 2006 see <http://mkkcclegisearch.metrokc.gov/detailreport/Reports/Temp/5420083534.doc>).



3.8 Conclusion: Building on existing practice and prioritising new opportunities for coastal communities

This chapter has outlined leading practice principles to guide local planning responses to climate change, emphasising implications for Australian coastal amenity communities. It has described a range of potential planning approaches that build on much of the work already being undertaken by many local governments both within Australia and internationally, but which takes on a new urgency in the context of future climate change scenarios. The chapter also outlined potential mitigation or adaptation responses that are well 'worth doing anyway', because they address issues already affecting coastal amenity communities, or represent new opportunities. In the following chapter we turn to the existing state of practice in planning for climate change mitigation and adaptation in Australian coastal areas.



4 Current state of practice in planning for climate change mitigation and adaptation in Australian coastal amenity communities

Over the past twelve months there has been a groundswell of research and activity on the potential impacts of climate change for Australia. This chapter reviews this work to establish current policy practice in planning for climate change mitigation and adaptation for Australian coastal amenity communities. The emphasis is on actions relating to the land use planning and development assessment responsibilities of local councils. The chapter also outlines relevant national, state and regional policy frameworks and initiatives for climate change mitigation and adaptation.

Policy arrangements, legislation, and administrative structures relating to coasts and the environment are extremely fluid in Australia and the information presented here was accurate at the time of writing (April 2008).

4.1 National, state and regional policy and planning for climate change in coastal Australia

Australia currently lacks an overarching national coastal policy. However, there are a number of administrative arrangements for coordination and intergovernmental cooperation relevant to the coast in general and climate change in particular. At the national level, the Intergovernmental Coastal Advisory Group brings together representatives from the Commonwealth, state and territorial governments, as well as the Australian Local Government Association, and provides a basis for national deliberation and collaboration on climate change.

Integrated Coastal Zone Management in Australia

Australia's "Framework for a National Cooperative Approach to Integrated Coastal Zone Management", developed by the national Natural Resource Management Ministerial Council promotes collaboration across five issues: land and marine based sources of pollution, introduced pest plants and animals, allocation and use of coastal resources, capacity building and managing climate change. Intergovernmental collaboration in planning for climate change, at local, state, or Commonwealth levels, may be pursued within the context of this framework.

Two of the six national priorities for coastal management (planning for population change and climate change) are of particular relevance to coastal amenity communities seeking to develop their own responses to climate change.

ICZM has been the basis of coastal management in Australia for the last 30 years. Despite this the State of Environment reports for 1996, 2001 2006 all indicate a gradual deterioration of the environmental condition of the coast. This indicates that more than the current approaches to ICZM is required in Australia.

National Climate Change Adaptation Framework

The Council of Australian Governments (COAG) also promotes collaborative action in addressing climate change across the Australian states and territories through its "Climate Change Group". One of the initiatives to emerge from this group is the National Climate Change Adaptation Framework, which outlines collaborative actions around adaptation for the period 2007-2014. This framework is intended to provide the information needed to understand and manage climate change risks to "water resources, biodiversity, coasts, agriculture, fisheries, forestry, human health, tourism, settlements and infrastructure" (Climate Change Group 2005 p. 3).

Administrative arrangements

The Department of Climate Change has administrative responsibility for Australia's climate change initiatives, under the umbrella of the National Greenhouse Strategy. The Australian Climate Change



Science Program is run by CSIRO in partnership with the Australian Bureau of Meteorology. This program coordinates information and undertakes research on climate change within the Australian region. This includes information about observed climate change over Australia, likely causes, and projected future scenarios.

Commonwealth environmental legislation and initiatives

Direct Commonwealth involvement in land use, environmental and coastal planning and management is limited but expanding. The Commonwealth governs decisions on its own land, and also regulates matters of “national environmental significance” under the Environmental Protection and Biodiversity Conservation Act (EPBC Act 2000) (world heritage areas, natural heritage places, Ramsar wetlands, threatened species and ecological communities, migratory species, Commonwealth Marine Areas, and nuclear actions). Currently the Act has no provisions relating specifically to climate change, aside from recognising climate change as a “Key Threatening Process” that may harm Commonwealth listed threatened species and their communities. However the Commonwealth does impact directly through its funding programs and particularly the Natural Heritage Trust, currently under review.

Environmental strategies relating to climate change include the National Biodiversity and Climate Change Action Plan and the National Agriculture and Climate Change Action Plan, prepared by the Natural Resource Management Ministerial Council. The ‘Climate Change Adaptation Actions for Local Government’ was released by the then Australian Greenhouse Office in 2007. This is a comprehensive reference point and resource for local governments in developing actions to assist in adapting to the impacts of climate change. The focus is on assessing and prioritising adaptation actions relating to key local government responsibilities. The Department of Climate Change provides funding and resources for Australian local government participation in the Cities for Climate Protection Program.

The Rudd Federal Government has also released a major policy statement ‘Caring for the Coast’ and initiated a Federal Parliamentary ‘Inquiry into climate change and environmental impacts on coastal communities’.

Professional bodies

Professional industry associations have been active in undertaking research and advice for members. The national engineering association Engineers Australia has issued guidelines for responding to the effects of climate change in coastal and ocean engineering (Engineers Australia 2004). The Planning Institute of Australia has issued a national policy position statement on planning for climate change (PIA 2007) and has undertaken research on planning for climate change adaptation (PIA 2004). Standards Australia has published a risk management standard for organisations across the public and private sectors (Standards Australia 2004).

4.2 States and territories

The Australian states and territories have established their own responses to climate change. Each state and territory government has prepared their own greenhouse action plan or equivalent. To date, mitigation actions have been the main focus of these plans. This has changed in the last two years with the establishment of Australia’s National Climate Change Adaptation Framework and the increased global emphasis on the need for adaptation.

Each of the States and Territories have also begun to strengthen other aligned policy areas like natural hazards, water, biodiversity, energy efficiency, and coastal management, as a way of improving potential resilience to climate change. Much work is also commencing to identify potential impacts at smaller geographical scales and in relation to particular sectors – infrastructure, health, economy and tourism, biodiversity, and agriculture.

Adaptation planning

Adaptation planning initiatives include:



- The NSW Biodiversity and Climate Change Adaptation Framework (managed by the Department of Environment and Climate Change) provides a basis for inter agency action on climate change, including research, monitoring and adaptation. Current initiatives include a study of climatic changes and coastal erosion, for 2030 and 2070 planning horizons, being undertaken by the CSIRO for the Department of Environment and Climate Change, and focusing on the Clyde River / Batemans Bay and Wooli Wooli river systems.
- The Queensland's Climate Smart Adaptation plan (2007-2012) establishes impacts of climate change and priority actions to increase resilience. The plan emphasises that adaptation actions must not replace actions undertaken to reduce greenhouse gas emissions, nor increase such emissions. It encourages knowledge sharing and partnership, in addressing climate change. It also encourages councils to consider commissioning their own climate change research and is establishing online resources to enable people to assess their own risk and vulnerability to climate change.
- The Victorian Government's Climate Change Adaptation Program was initiated in 2006. The program coordinates the work of different government departments involved in climate change programs, by increasing scientific knowledge and adaptive capacity. The program sponsors research as well as collaboration at local and regional levels. Key research and policy development areas are management of natural hazards, coastal erosion and flooding, agriculture, infrastructure and homes, and health.
- The Draft Victorian Coastal Strategy (2007) includes an increased emphasis on climate change. It provides baseline data to inform planning on potential sea level rise and more frequent and intense storm events, emphasising the need to avoid development on low lying areas vulnerable to future extreme weather like strong wind and waves and their impact on erosion and infrastructure. Set backs are promoted to accommodate anticipated climate change impacts such as sea rise and to provide a natural buffer for biodiversity resilience. The draft strategy outlines planning principles for new settlements, which include potential for future hazards such as sea level rise. These principles must be observed when planning to accommodate climate change impacts for existing and new communities.

Mitigation

Many states (including Western Australia, Victoria and NSW) have introduced energy efficiency requirements through their statutory planning frameworks and building codes. NSW state planning policy and requirements promote climate change mitigation and adaptation through minimum energy and water efficiency standards for residential development, alterations and additions (under the State Environmental Planning Policy – Building Sustainability Index 'BASIX' instrument). The tool is sensitive to different climatic zones across the state and requires design and performance standards in line with these zones.

Hazards and coastal management

Several states have enhanced their flood management requirements in response to the potential of more intensive floods and coastal water inundation from storm surge.

- State planning requirements in South Australia and Western Australia have long included provisions for local governments to maintain a coastal setback planning control to accommodate potential sea level rise.
- In Tasmania, indicative mapping of coastal vulnerability has provided an important source of information for land use planning and the identification of potential increases in coastal hazards and erosion (Sharples 2006).



- Queensland's natural hazard policies are combined within the State Planning Policy 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide. Under this policy, climate change is an explicit consideration when developing a natural hazard mitigation strategy.
- In NSW, Coastal Management Committees, managed by local councils, are preparing coastal management plans with explicit provisions for identifying and accommodating the impacts of climate change for coastal hazards. The NSW government supports this process by offering 50 per cent subsidies for Councils to prepare coastal studies and management plans, as well as conservation and beach improvement works. The Comprehensive Coastal Assessment (CCA) framework prepared by the NSW Government (Department of Planning 2006) provides a methodology and data base tools for coastal councils in NSW to develop population planning scenarios, including the consideration of potential climate change effects, although actual data availability was limited at the time of writing.

Collaborative initiatives

In Western Australia, the Indian Ocean Climate Initiative involves the State Government, CSIRO and the Bureau of Meteorology in assessing climate variability and change in Western Australia. The Queensland Government has established a cooperative research centre the 'Queensland Climate Change Centre of Excellence' in the Office of Climate Change within the Environmental Protection Agency. The Centre is undertaking research on climate change impacts, focusing on key sectors (water planning, agriculture, human settlements, natural environment and landscapes, emergency services and human health, insurance and finance) (QLD EPA 2008).

4.3 Local planning responses to climate change in Australian coastal communities

Despite the increasing range of climate change related activities at state and Commonwealth levels, information about the extent to which local governments in Australia are planning for climate change is limited. A national analysis of information and data gaps in understanding coastal vulnerability to climate change undertaken by the then Australian Greenhouse Office in 2006 highlighted a need to survey the national status of planning schemes and the ability of coastal councils to apply climate change information in their planning activities (AGO 2006, p. 13).

The exhaustive review of literature and research on Australasian responses to climate change undertaken by the IPCC emphasises that mitigation approaches are more advanced than those relating to adaptation planning (Henessey et al. 2007). In Australia, such approaches relate particularly to improving the carbon performance of local government operations and activities, for instance, switching to energy efficient light globes and more efficient fleet vehicles. There has been very limited research or development work on how to integrate climate change considerations, particularly relating to adaptation, within statutory planning frameworks within Australian local planning practice (Chew 2007, PIA 2004).

In NSW, a survey of 113 local councils found very little involvement in planning for either climate change impacts or mitigation (LGSA 2006). Actions to prepare or amend planning instruments, either for climate change mitigation or adaptation were undertaken by only eight per cent of respondents, while 11 per cent reported developing climate change policies (LGSA 2006, p. 9). About 18 per cent of councils responding to the NSW survey report on greenhouse gas emissions through their state of the environment reporting framework, and 14 per cent were involved in the Cities for Climate Change Program, although this percentage is likely to have increased in the past two years.

In Victoria, a review of local government initiatives on greenhouse and climate change identified eleven initiatives ranging from information forums to engage councils and local residents, projects to track energy use or reduce energy consumptions in municipal buildings and small businesses, a sustainable transport strategy, sustainable design of a new council building, and regional partnerships (Atkinson et al. 2007). However, the study reports that 82 per cent of Victorian councils participate in the ICLEI Cities for Climate Protection (CCP) program.



Australian Urban Land Use Planning Policy Monitor: Climate change responses of local government

A national survey of local planning frameworks being undertaken by researchers at the Universities of Sydney and Western Sydney under the Australian Urban Land Use Planning Policy Monitor, reports similar rates of local government engagement with climate change. Of the 107 local councils involved in the first survey round (conducted May – June 2007), only four report including specific approaches to climate change within their statutory planning frameworks, although state government provisions relating to sea level rise are incorporated within local plans in South Australia and Western Australia (<http://ppm.arch.usyd.edu.au>).

However, a higher proportion of councils have provisions within their statutory planning frameworks that may provide indirect protection from climate change impacts, or a basis for strengthening protections in the future. For instance, 21 of the responding 79 coastal councils include specific coastal protection zones or equivalent. Other mechanisms that may contribute to the adaptive capacity of local communities under future climate scenarios include bushfire protection zones, overlays or equivalent (41 councils); local planning policies, zones or overlays to protect wetlands (43 councils), native vegetation (55 councils) and wildlife habitat (48 councils) as well as water savings and water sensitive urban design requirements (20 councils).

This suggests that many Australian local councils already have the basis for incorporating climate change considerations within their legislative decision making and development assessment framework. Similarly, many councils have well established approaches to promote more sustainable urban forms, providing a sound basis for reducing harmful greenhouse gas emissions and for settlements that are more resilient to some of the impacts of climate change (particularly increased temperatures and drought).

Planning controls that assist in mitigating greenhouse gas emissions include requirements for passive energy utilisation (24 councils); and requirements for retention and replanting of endogenous (local species) (39 councils). Seventeen respondents to the national survey include requirements for waste minimisation in the construction and operation of new developments, while only 15 councils require bicycle paths or dedicated lanes within new developments. Twenty six councils contain statutory requirements for footpaths or walkways within their local plans.

Overall, the first tranche of responses from the planning policy monitor suggests that innovation in the use of planning tools for climate change mitigation and adaptation and for environmental sustainability more broadly is limited in Australia. Only nine councils report approaches to enable environmental trade offs within their planning schemes, but 14 permit clustering of development on less sensitive areas of environmentally significant sites to ensure protection without foreclosing development potential, and seven councils implement incentives for voluntary landholder conservation agreements. Further work to develop and extend such tools is likely to be needed in order to adapt to some of the specific implications of climate change for coastal amenity communities.

4.4 International responses

Before turning to opportunities for strengthening climate change planning within Australian coastal amenity communities, it is helpful to benchmark progress against planning work being undertaken by local governments internationally. As in Australia, specific climate change responses at local government level were initially focused on corporate mitigation strategies, with some notable exceptions. The United Kingdom government has taken a lead in developing advice for local governments to assess their potential vulnerability to climate change, as well as ways to improve the carbon performance of new planned settlements (DCLG 2007, ODPM 2004). National planning legislation in New Zealand was amended in 2004 to incorporate climate change as a matter to be considered during plan making and development assessment (New Zealand Climate Change Office 2004). Box 7 summarises initiatives undertaken in nations with comparable planning frameworks to



Australia and documented coastal amenity pressures (the United States, the United Kingdom, and New Zealand).

4.5 Summary and conclusion

This chapter has outlined the Australian policy framework for managing climate change in coastal areas. It has identified processes and initiatives stemming from national, state and local levels of government to adapt to the potential impacts of climate change and to mitigate greenhouse gas emissions through sustainable urban form and new technologies. We have highlighted increasing activity at the Federal government level to address the specific implications of climate change for coastal areas, although far more needs to be done in this area, as we emphasise in the following chapter. Our review of state and local planning approaches to climate change shows that while innovation is emerging, a consistent approach to planning for climate change in coastal Australia is far from mainstream. While Australia is not unique in this regard, arguably local governments in the United Kingdom and the New Zealand governments have benefited from earlier, high level legislative and policy support for the integration of climate change considerations in plan making and development assessment.



Box 7: International Approaches

The United States

In the United States, local government action relating to climate change is not yet mainstream, but there are some notable exceptions. For instance, the coastal city of Olympia in Washington has undertaken a wide range of climate change initiatives since 1991. Adaptation efforts have focused on managing risks of inundation of low lying coastal areas of the city and the integrity of the drinking water supply. Comprehensive mitigation measures include land use and transportation policies to reduce car use, forest conservation and tree planting to mitigate greenhouse gas emissions, and a zero waste management plan (University of Washington and King County Washington, 2007).

The US branch of the International Cities for Local Environmental Initiatives (ICLEI) Climate Resilient Communities Program has sponsored a number of pilot adaptation planning projects. The City of Keene in New Hampshire demonstrates a methodology for vulnerability assessment analysis and adaptation planning that can be undertaken by a committee of local government staff and community members, without the need for additional science (The Heinz Centre 2007). Adaptation goals are formulated through a democratic process of prioritisation.

The United Kingdom

The United Kingdom government has sponsored a range of national planning activities and consulted broadly on specific policy guidance addressing land use planning for climate change (incorporating both mitigation and adaptation responses). At the regional level in the United Kingdom, there have been a number of strategies focusing on climate change impacts for coastal tourism areas. Actual amendment of planning controls and instruments to take climate change impacts into account (from sea level rise and erosion to mitigating greenhouse gas emissions) is still relatively rare and limited to plans prepared or amended within the past five years.

New Zealand

The New Zealand National Climate Change Office within the Ministry for the Environment coordinates policy and programs relating to climate change. An amendment to the New Zealand Resource Management Act (which governs environmental planning and assessment in New Zealand) includes climate change as an “other matter” to be considered when development proposal are assessed under the Act and when new plans are prepared (the Resource Management (Energy and Climate Change) Amendment Act 2004). The Act now requires two aspects of climate change to be considered – potential impacts of climate change and the potential benefits associated with the use of renewable energy. Guidance has been prepared for local governments to assist them in assessing climate change effects, including up to date information on climate change impacts for New Zealand by region. The New Zealand National Climate Change Office has also prepared manuals for local government in managing coastal hazards and climate change (New Zealand Climate Change Office 2004).



5 Enhancing practice in planning for climate change in coastal amenity regions – local government opportunities and priorities for support

In this concluding chapter of the report, we first present a new way to prioritise support for communities affected by climate change, by determining highest levels of social vulnerability. We then summarise leading practice approaches to climate change in a series of matrices according to the themes of environment, community, economy and tourism, infrastructure and governance. We show that many approaches meet multiple objectives in addition to climate change mitigation or adaptation. We then turn to the opportunities and priorities for supporting coastal communities in planning for climate change, highlighting four critical areas – policy and legislation; technical data and interpretation; financial incentives and pricing policy; and collaboration and capacity building at the time the research was carried out.

5.1 Preliminary assessment of community social vulnerability to climate change in amenity regions of coastal Australia

Time, money, and attention needs to be prioritised to the sites and policies where they will accomplish the most good in addressing climate change in coastal amenity communities in Australia. In determining this, a wide variety of factors must be considered, including:

- Current community 'carbon footprint' – level of local contribution to the global problem;
- Climate vulnerability, which we address in previous sections;
- Social vulnerability, which has been less documented; and,
- Efficiency and effectiveness of specific actions.

A full scale analysis of all four main factors of the Sea Change communities was beyond our scope. However, given that there is less information on social vulnerability, we report on a preliminary assessment of relative social vulnerability to climate change impacts. The assessment was undertaken as part of a broader analysis of 2006 census data and sea change communities (Gurran and Squires forthcoming). It was developed by assigning a rating to all 67 local government members of the National Sea Change Taskforce.

The rating uses four indicators identified in international research on community vulnerability to disasters. These include age – older people and those whose health is compromised are at greater risk of injury, death or illness during a disaster or extreme weather events (Cutter and Finch 2008, Rosenkoetter et al 2007); income – lower income households have fewer resources to prepare for potential disaster, recover during a post disaster period, or manage during extreme weather (Levine et al. 2007, Masozera et al. 2007); population turnover rates as newcomers to an area are at greater danger during a natural disaster because they are unfamiliar with management processes and often unconnected to access information networks (Few 2007, Levine et al. 2007); and rental tenure – those in rental accommodation are less able to adapt their homes to withstand climate change impacts or risks (Burby et al. 2007). Renters are also more likely to be displaced from their housing if it is damaged during a natural disaster.

Density of population is also as an indicator of social vulnerability to natural hazards (Masozera et al. 2007, Victorian Department of Human Services). In many nations density is a proxy for social disadvantage and density has not been found to increase vulnerability within more affluent communities (Cutter and Finch 2008). As density is not generally correlated with social disadvantage in Australia, and dispersion of population rather than density characterises most coastal amenity areas (with the notable exception of coastal cities like the Gold Coast) we did not include this indicator in our

preliminary analysis of social vulnerability to climate change. However, we emphasise that density of population is an important factor in determining emergency and hazard responses.

The following four indicators use 2006 ABS census data to compile the preliminary index:

- Median Age (communities with a higher median age were given a lower rating);
- Median Income (communities with a lower median income were given a lower rating);
- Recent in-migrants (communities with a higher proportion of people who moved from outside the LGA in the past five years were given a lower rating); and,
- Renters (communities with a higher proportion of rental properties in the LGA were given a lower rating).

The following table shows the outcome of this analysis, highlighting communities in the sample which are likely to have the greatest levels of social vulnerability to climate change impacts. Note that tenancy (rental vs. homeowner) and income are related, so while it is important here to capture the effects of both, they tend to reinforce the results. The lower the rating the higher the community's vulnerability, the higher the rating, the lower the community's relative vulnerability in relation to other Australia coastal amenity communities.

Table 4: Communities Most Vulnerable and Least Vulnerable to Climate Change Impacts

Vulnerability Rating	'Most Vulnerable'	Vulnerability Rating	'Least Vulnerable'
68	Hervey Bay	204	Glenelg
79	Denmark	204	Wollongong
81	Exmouth	205	Calliope
87	Noosa	207	Gosford
92	Victor Harbor	209	Moyne
93	Great Lakes	218	Surf Coast
95	Tweed	219	Capel
96	Caloundra	220	Rockingham
100	Miriam Vale	227	Kiama
101	Eurobodalla	227	Wanneroo
101	GlamorganSpring Bay	230	Kingborough

Source: Gurran and Squires 2008, forthcoming.

Understanding levels of social vulnerability provides an indication of where additional strategies may be needed to assist communities to adapt to climate change impacts. In locations where social resources are greater – due to higher household incomes, more diverse age profiles, and community stability, the capacity of populations to independently adapt to the impacts of climate change is greater. Amongst lower income and less stable populations, the capacity to absorb higher prices (for instance, associated with a carbon tax) or undertake modifications to dwellings for safety or thermal comfort is much reduced.

As shown in the table, according to the indicators used, the 'most vulnerable' communities are Coastal Lifestyle Destinations and Coastal Getaways which are significant retirement destinations, such as Hervey Bay, Eurobodalla and Victor Harbor. Large, Coastal Commuters, located close to the capital cities were most commonly rated as 'least vulnerable', like, Wollongong, Gosford and Wanneroo.

In determining actions to take, local communities can first consider their responsibility to act given the level of their contribution to the global problem, and then consider their particular environmental



forecasts, appropriate policies, and their level of social vulnerability to ascertain what types and levels of action seem most important right now. The policies presented below can be selected from with these considerations in mind.

5.2 Leading practice approaches to climate change: prioritising local actions for multiple benefits

We have emphasised in this report that climate change must become a mainstream or standard consideration when preparing land use plans, making decisions about future infrastructure provision, or reviewing a development proposal. As well as better preparing the community for potential impacts associated with climate change, there is an opportunity to benefit from actions that improve climate resilience but also have important environmental, community or economic benefits for the local community.

The following matrices (Tables 5-9) summarise leading practice approaches in planning for climate change as outlined above, highlighting approaches that are likely to have multiple benefits in the short term. Relevant local government examples are also provided, where available.

As emphasised in this report, and shown in the following environment matrix (Table 5), many actions primarily designed to improve coastal defense systems to manage changed climate scenarios will benefit coastal ecosystems, irrespective of potential climate change impacts. For example, creative use of coastal setbacks and the use of planning system incentives and requirements for biodiversity conservation provides an opportunity to improve scenic amenity.

Planning now for climate change reduces the potential economic losses arising from future exposure to climate change risk. Strategic planning to facilitate carbon neutral and climate resilient forms of technology also provides an opportunity to capitalise on economic opportunities associated with climate change (Table 6). Many climate appropriate responses to perennial challenges faced by sea change communities reinforce the natural asset base on which these areas depend for quality of life and for ongoing tourism and visitor appeal.

Climate friendly forms of settlement planning can contribute to sustainable and cohesive communities. Opportunities for nature based recreation are provided when climate change strategies to reduce reliance on polluting forms of transport translate to the creation of additional walkways, cycle paths, habitat protection areas and shared spaces for nature appreciation and contemplation (Table 7). A climate sensitive approach can mean planning ahead for reconstruction and an enhanced settlement in an easier to service location.

Many forms of climate resilient infrastructure offer environmental and economic benefits to coastal communities (Table 8). International practice in new local infrastructure provision emphasises decentralised forms of renewable energy, and water conservation, retention and reuse facilities at site or neighbourhood scale.

Planning for climate change offers an opportunity to strengthen collaboration with neighbouring local government areas and with other government and non government agencies (Table 9). Climate change issues are of high importance to members of the community and are likely to engage a cross section of residents in deliberating about potential planning goals and responses to climate change mitigation and adaptation. This provides an opportunity to build greater community cohesion.

Table 5: Multiple benefits in prioritising local actions for climate change in Australian coastal amenity communities: Environmental matrix

	<i>Adaptation</i>	<i>Mitigation</i>	<i>Environment</i>	<i>Community</i>	<i>Economy</i>	<i>Infrastructure</i>	<i>Government</i>
Environment							
Biodiversity							
Use coastal setback areas to reintroduce and restore local biodiversity, protect important vegetation and coastal habitat within an environmental protection zone or equivalent.	✓	✓	✓		✓		
Connect habitat through dedicated habitat protection corridors	✓	✓	✓		✓		
Create planning system incentives and requirements for new developments to retain and restore local biodiversity.	✓	✓	✓		✓		
Coastal processes and beaches							
Protect low lying and exposed areas, and reintroduce natural 'soft' defense measures.	✓		✓			✓	
Prohibit development that threatens coastal processes or requires filling of wetlands or mangroves. Require referral to expert agencies for development in particularly vulnerable areas or of a certain scale.	✓		✓				
Introduce environmental assessment requirements for areas where existing information is insufficient to determine the impact of potential development scenarios without additional and costly research.	✓		✓				
Natural hazards							
Specify sea level / natural hazard thresholds or indicators (informed by climate projections) as a basis for setting coastline building rules for setback / removal of buildings.	✓		✓			✓	
Revise land use designations and permitted building forms in light of natural hazard assessment.	✓		✓		✓	✓	
Establish policy framework for re-situating land uses that may become unsafe or unsuitable in the future due to climate change.	✓		✓		✓	✓	



Table 6: Multiple benefits in prioritising local actions for climate change in Australian coastal amenity communities: Economy matrix

Economy	Adaptation	Mitigation	Environment	Community	Economy	Infrastructure	Government
Identify sites or precincts where climate technology (like renewable energy or carbon sequestration) can be developed or demonstrated. Implement supportive planning controls.	✓	✓			✓		
Tourism							
Ensure that new tourism developments are not exposed to future climate change impacts.	✓			✓	✓		
Improve climatic comfort of key destinations through climate sensitive urban design	✓	✓	✓	✓	✓	✓	
Feature climate friendly design requirements for tourism development, appealing to eco tourism markets.	✓	✓	✓	✓	✓	✓	
Agriculture							
Enable multi function use of agricultural lands, provided that additional uses do not threaten the long term agricultural quality of the land.	✓				✓		
Support planning policies that prioritise and foster local food production and consumption.	✓	✓	✓	✓	✓		
Fisheries							
Protect wetlands and require natural buffer areas between agricultural lands and waterways, to reduce impacts of flooding on marine life	✓		✓		✓	✓	
Refer significant agricultural land use change proposals on flood risk areas to state government agencies responsible for fisheries.	✓		✓		✓		



Table 7: Multiple benefits in prioritising local actions for climate change in Australian coastal amenity communities: Community wellbeing matrix

Community wellbeing	Adaptation	Mitigation	Environment	Community	Economy	Infrastructure	Government
Health							
Tailor urban and building design guidelines to local climatic conditions.	✓	✓	✓	✓	✓	✓	
Consider impact of planning requirements on potential for spread of water borne and vector borne disease							
Require shading, shelter, and appropriate vegetation to cool areas of open space and walkways or cycle paths.	✓	✓	✓	✓	✓	✓	
Review design standards for manufactured home estates and caravan parks.	✓			✓			
Quality of life and amenity							
Increase coastal setbacks and natural or 'soft' defense measures through land use overlays and planned retreat zones	✓	✓	✓	✓	✓	✓	
Use natural restoration works to increase visitor and recreational opportunities associated with the area	✓	✓	✓	✓	✓	✓	
Increase opportunities for nature based recreation, by identifying and preserving walkways and areas of natural habitat and vegetation	✓	✓	✓	✓	✓	✓	
Use urban shade strategies to improve visitor facilities and outdoor amenity.	✓	✓	✓	✓	✓	✓	
Emergency management							
Maintain space for emergency access, shelter and evacuation; reserve locations for intermediate post emergency recovery (these locations may be multi-function)	✓						
Actively plan ahead for settlement reorientation or design following a major natural disaster, and ensure supportive land use decisions.	✓						



Table 8: Multiple benefits in prioritising local actions for climate change in Australian coastal amenity communities: Infrastructure matrix

Infrastructure	Adaptation	Mitigation	Environment	Community	Economy	Infrastructure	Government
Assess location of and design standards for existing and planned infrastructure, and assess vulnerability to climate change impacts.	✓					✓	
Revise infrastructure capacity plans to take future climate scenarios into account, rather than historical weather events, and adjust settlement thresholds accordingly.	✓					✓	
Identify and reserve locations for relocation of major infrastructure and for new decentralised energy, water, or waste management plants.	✓	✓	✓				
Prioritise new infrastructure that delivers multiple environmental services while reducing carbon footprint and serving basic settlement needs.	✓	✓	✓			✓	
Major developments should self provide basic infrastructure services – energy, water, waste, through strategies such as micro energy generation, water retention, demand reduction technologies, reuse, and recycling; and waste minimisation, reuse, and disposal.	✓	✓	✓		✓	✓	
Water							
Emphasise the protection of natural hydrological systems to improve their resilience to possible climate change impacts.	✓		✓			✓	
Prioritise water supply options that are associated with minimal contributions to climate change impacts, including water demand management strategies particularly developments associated with major water needs like tourist facilities.	✓	✓			✓	✓	
Maintain spaces for floods and water retention in regions where rainfall patterns are likely to become more volatile.	✓		✓				



Table 8 (Cont.): Multiple benefits in prioritising local actions for climate change in Australian coastal amenity communities: Infrastructure matrix

Infrastructure	Adaptation	Mitigation	Environment	Community	Economy	Infrastructure	Government
Transportation							
Design and reconfigure settlements to reduce the need for trip generation and to maximise potential viability of public transport. Assess the transportation impacts of all major new developments.	✓	✓	✓	✓	✓	✓	
Ensure that new settlements are accessible by all weather roads or alternative routes.	✓			✓		✓	
Prioritise attractive and well shaded walkways and cycle paths, linking residential, retail, and recreational precincts.	✓	✓	✓	✓	✓	✓	
Energy							
Draft renewable friendly energy planning codes, that enable broader environmental benefits to be assessed alongside local impacts.	✓	✓	✓	✓	✓	✓	
Create planning requirements for major new developments to utilise local sources of renewable energy as much as possible, or provide offset payments to stimulate investment in local energy generation.	✓	✓	✓		✓	✓	
Protect solar access to ensure that developments retain capacity for onsite solar energy generation.	✓	✓	✓	✓	✓	✓	
Enforcing building and urban design requirements that minimise energy requirements and maximise thermal comfort.	✓	✓	✓	✓	✓	✓	
Waste							
Reserve local sites to accommodate waste sorting, recycling and reuse, and requiring that major developments include a sustainable waste strategy as a condition of planning approval.	✓	✓				✓	
Establish provisions for composting at site or neighbourhood level, to reduce waste in land fill and to assist in reducing water needs.	✓	✓				✓	



Table 9: Multiple benefits in prioritising local actions for climate change in Australian coastal amenity communities: Governance matrix

Governance	<i>Adaptation</i>	<i>Mitigation</i>	<i>Environment</i>	<i>Community</i>	<i>Economy</i>	<i>Infrastructure</i>	<i>Government</i>
Governance							
'Mainstream' climate change as part of all planning and management decisions. Adopt strong objectives for climate change mitigation and adaptation within statutory land use plans.	✓	✓	✓		✓	✓	
Collaborating with other local governments at regional or sub regional level on future climate scenarios and potential responses.	✓						✓
Establishing effective and ongoing public involvement processes for information and deliberation on the identification and prioritisation of climate mitigation and adaptation responses.	✓	✓		✓			✓



5.3 Enhancing practice: priorities for support

Local governments, particularly those in smaller non metropolitan coastal areas, need support in developing, implementing and defending climate change responses on the ground. Support is needed in four critical areas – policy and legislation; technical data and interpretation; financial assistance; and collaboration.

Policy and legislation

As emphasised in this report, coastal councils are at the frontline of development and infrastructure planning decisions that will ultimately determine the level of exposure of individuals and communities to potential climate change impacts. Drawing on international practice, such decisions must be situated within a broader policy and legislative framework for managing coastal development and for addressing climate change. Earlier work has called for a national coastal policy, expressing a positive vision for managing coastal growth to benefit regional Australia without diminishing our precious coastal landscapes and environments or overwhelming existing coastal towns (Gurran et al. 2005). Such a framework would provide the basis for consistent reinforcement through state policy and legislation and through local planning decisions. Within this framework, a national policy position concerning climate change and adapting coastal environments and settlements to potential impacts would enable consistent implementation across the Australian states and territories.

Currently, the onus is on the States and territories, responsible for land use and environmental planning legislation, to establish sufficient direction and support for local governments to develop and enforce their own positions in relation to climate change. This framework should establish a positive vision for carbon neutral and climate change resilient settlements.

At a more detailed level, state planning legislation and policy must clarify local government obligations in relation to specific development that may present unacceptable risk of greenhouse gas emissions or exacerbate exposure to climate change. Similarly, state legislation and policy must also support local governments in other defined circumstances where it is prudent to monitor and await further information before making a decision that has significant financial consequences.

These are important attributes of an effective national, state and local policy and planning framework for climate change. The particular exposure of smaller, coastal amenity locations to rapid growth and intense weather events means that a national policy and planning framework for climate change has special urgency for these communities.

Technical data and interpretation

A reliable and consistent source of scientific data about climate change projections and impacts is essential if climate change is to become a mainstream consideration in local land use planning, infrastructure management, and development assessment. While national and some regional level data exists, much potential for inter and intra regional variation remains. Given the considerable uncertainty that exists about potential climate change scenarios and the further uncertainty about the actual impact of these scenarios, it is critical that projections are sourced from an independent scientific authority and based on a consistent methodology.

The national risk assessment of vulnerability to climate change announced by the Council of Australian Governments in February 2008 will provide an important source of information for coastal councils provided that it is supported by detailed, local and regional scale data able to be incorporated in local planning schemes. This data must be freely available and updated on a regular basis.

Interpreting current estimations at a locally differentiated scale – as advice for local government planners – would provide an important interim measure. Assistance with interpreting scientific data about local climate change forecasts and impacts will also be imperative if local authorities, particularly the more remote coastal hamlets, are to incorporate climate change as a mainstream consideration in development assessment. Climate change planning circulars provided directly to state and or local



governments would provide a basis for updating or enhancing local planning controls or environmental assessment criteria.

Financial support and assistance

Many coastal amenity councils experience particular budgetary pressures associated with their limited rate base, and the need to provide infrastructure and services for high and fluctuating non resident populations. Planning for climate change and adapting infrastructure to withstand increasingly uncertain weather conditions will test these financial resources even further. If financial assistance is provided to local authorities, particularly those in climate change hotspot zones, there is an opportunity to guide the quality of adaptation response.

Two funding priorities emerge from the review of climate change impacts for coastal amenity communities presented in this report. The first is to resource climate change planning processes for local coastal communities across Australia. A methodology for assessing climate change vulnerability and for identifying actions to increase resilience should be rolled out as a key national level coastal initiative. As noted in chapter 3, an initial example of this has been developed by ICLEI, and is available on line, but it will need to be adapted to Australian national, state and local conditions (<http://www.iclei.org/index.php?id=7066>). Economies of scale and the potential to establish a consistent data set and adaptation responses suggest that the assessments themselves should be undertaken in partnership with local government, but not by local government acting alone. Following local vulnerability assessment and identification of necessary land use planning considerations and requirements, statutory planning frameworks will need to be amended. Some smaller councils are likely to require resources and technical assistance to complete this work.

The second funding priority is to assist in the transition to carbon friendly and climate resilient forms of infrastructure and industry. The combination of start up resources for decentralised and sustainable water, energy and waste management facilities, linked to planning requirements or incentives established by local governments, would provide both the requirement to shift to more renewable sources of energy and the carrot to make this transition more economically viable.

Capacity building and collaboration

Regional collaboration with other local authorities on small scale climate forecasting and impact research, and to develop strategies to address these forecasts is becoming increasingly common. Regional collaboration provides a way for local governments to directly share resources (for instance, the cost of a climate change study) and to achieve a consistent range of responses to it. Smaller councils and new members of council staff often gain greatly by working with another local authority so collaborative strategies also foster local capacity to address the impacts of climate change and to respond to potential impacts. The climate change work by the Gippsland Regional Coastal Board in partnership with the CSIRO is a good example of relevant applied research at the regional level. Another example is the Western Port Greenhouse Alliance which provides a strong regional framework for stakeholders to pool resources for collaborative research and other initiatives as noted above (Atkinson et al. 2007).

A possible Intergovernmental Agreement between the national, State and local government could be developed to support intergovernmental cooperation on addressing the critical issues identified in this report concerning climate change and local communities.

5.4 Conclusion: Meeting the climate change challenge in coastal amenity communities of Australia

This report has highlighted two primary threats associated with climate change for coastal amenity areas in Australia. The first is the physical exposure of many coastal settlements to increased natural hazards, which threaten human safety, lifestyle, physical assets, and tourism and agriculture based economies. But coastal amenity communities are not only physically vulnerable to climate change. The particular socio-economic profile of sea change communities, means that many of these areas have higher levels of social vulnerability, reducing their capacity to adapt to climate change risk.



The work presented here also outlined the critical need to “mainstream” climate change adaptation and mitigation considerations in land use planning and development assessment, through frameworks able to respond to unexpected changes or new scientific information as it comes to hand. Local government, especially coastal councils, are at the frontline of the spectrum of impacts associated with climate change but they are not able to respond to these in isolation.

In conclusion, we propose the following recommendations for agencies at local, state and Commonwealth levels to support and enhance practice in planning for climate change coastal amenity communities.

1. That all State and territorial planning authorities enact high level planning policy to ‘mainstream’ climate change mitigation and adaptation considerations in all coastal planning decisions, to ensure long term liveability and adaptability for coastal communities.
2. That in response to climate change, local councils undertake an initial vulnerability assessment incorporating:
 - Existing information and potential risks of climate change;
 - The capacity of existing systems or processes to adapt to these impacts; and,
 - The potential to introduce new adaptation strategies.
3. That a formal climate change vulnerability assessment be undertaken at regional or local scales to support strategic land use planning decisions and significant development assessment in coastal amenity areas, including:
 - The existing and potential exposure of particular locations / infrastructure to risks associated with climate change and the potential to reduce this vulnerability through specific building standards, development controls, or direct works;
 - The potential impact of the settlement or infrastructure, including the location and configuration of development, on the vulnerability of existing settlements, natural habitat or biodiversity, including ‘downstream’ impacts;
 - The location of existing and planned settlements / developments in relation to access routes, services, and infrastructure, and the likelihood of continued access to these facilities in the event of an emergency, and;
 - The potential to reduce risks and the potential to further adapt the development / activity if climate impacts accelerate or increase.
4. That carbon impact of future land use or development forms must become an explicit consideration in all strategic land use planning and development assessment processes in coastal areas, including:
 - The ability to service locations with alternative transportation, like public transport, walking, and biking, and the general contribution of the location to reductions in auto trip numbers and length, to assure that the location works toward climate change mitigation;
 - The scale and duration of the impact, both of the primary development itself (and associated construction), and potentially, any ‘downstream’ impacts.
 - Ways to avoid, negate, or offset the impact of the development on greenhouse gas emissions and any existing or potential legal duty of care to consider direct or indirect carbon impacts of the development.
5. That in any adaptive response to climate change, consideration be given to the possible ‘equity’ issues that may arise as a result of financial (eg pricing policy) or regulatory (eg building codes), and the differential impacts for particular members of coastal communities that may be particularly vulnerable to pricing or regulatory changes.
6. That a mechanism be established to encourage and enable collaboration between neighbouring local councils in responding to climate change.



7. That Federal and State governments support local councils in building expertise and in undertaking the necessary vulnerability assessments and adaptation planning work with dedicated funding and data resources.
8. That further research on understanding and responding to social vulnerability to climate change impacts be undertaken, with priority assistance given to coastal areas where physical exposure, socio-economic disadvantage, and population instability coincide.
9. That an intergovernmental agreement involving all three levels of government be developed to clearly state the commitments and responsibilities of Federal, State and Local Government in planning for climate change.

Leading practice in planning for climate change will not arise by accident. Nor is it desirable or realistic to expect most coastal local government areas, particularly those servicing relatively small and remote populations, to develop appropriate responses without assistance from other levels of government. Rather, local governments will need considerable policy advice, technical support, and financial aid in developing, implementing and extending work already underway to adapt to climate change impacts across coastal Australia. Planning now for climate change will certainly improve medium and long term community resilience to potential climate change scenarios, but will also result in tangible economic, social, environmental and lifestyle benefits for coastal amenity communities today.



6 References

ABS 2001, Energy and greenhouse gas emissions accounts, Australia, 1992-93 to 1997-98, Catalogue 4604.0, Canberra.

Allen Consulting Group (2005) Climate Change Risk and Vulnerability: Promoting an efficient adaptation response in Australia, Final Report to the Australian Greenhouse Office, Department of the Environment and Heritage, Canberra.

Australian Bureau of Statistics (ABS 2003) Year Book Australia, 2003 , Catalogue 1301.0, Canberra.

Australian Greenhouse Office 2007, Australia's Coasts – Impacts of Climate Change; <http://www.greenhouse.gov.au/impacts/coastas.html> accessed 10/12/07

Australian Greenhouse Office 2007, Australia's Settlements and information on impacts of climate change. www.greenhouse.gov.au/impacts/settlements.html , accessed 10/12/07

Beatley, T 2004, Native to Nowhere; Sustaining Home and Community in a Global Age, Island Press, Washington

Beeton RJS , Buckley K I, Jones G J, Morgan D, Reichelt R E, Trewin D 2006, Australia State of the Environment 2006, Independent report to the Australian Government Minister for the Environment and Heritage, Department of Environment, Water, Heritage and the Arts, available online @ <http://www.environment.gov.au/soe/2006/publications/report/index.html>.

BRANZ Ltd 2007, An Assessment of the need to adapt buildings to the unavoidable consequences of climate change, Report to the Australian Greenhouse Office Department of the Environment and Water Resources August 2007, AGO, Canberra

Bulkeley, H and Betsill, M 2003, Cities and Climate Change, Routledge, Oxon.

Bulkeley, H and Kern, K 2004, 'Local Climate Change Policy in the United Kingdom and Germany', Discussion Paper SP IV 2004-103, Berlin.

Burby, R.J., Steinberg, L.J., & Basolo, V. (2003) 'The Tenure Trap; The Vulnerability of Renters to Joint Natural and Technological Disasters', Urban Affairs Review, 39(1), pp. 32-58.

Burton, D 2007, Evaluating Climate Change Mitigation Strategies in South East Queensland, Urban Research Program Research Paper 11, March 2007

Cameron, E. W. Russel, R.C, 2005, Living with Mosquitos in the Lower Hunter and Mid North Coast Region of NSW, NSW Premiers Department, Hunter NSW 2005

Centre for Science in the Earth System (The Climate Impacts Group), Joint Institute for the Study of the Atmosphere and Ocean University of Washington and King County, Washington 2007, Preparing for Climate Change: A Guidebook for Local Regional, and State Governments, September 2007, Washington, <http://www.cses.washington.edu/cig/fpt/guidebook.shtml>, accessed 15 January 2008.

Chew, J 2007 "Planning Policies for Climate Change at the Local Level: Lessons for Australia", unpublished masters dissertation, University of Sydney December 2007.

Christensen, J.B., Hewitson, A. Busiuc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W. –T. Kwon, R. Laprise, V. Magana Rueda, L. Mearns, C.G. Menendez, J. Raisanen, A. Rinke, A. Sarr and P. Whetton, 2007, Regional Climate Projections, In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S. D., Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M Tignor and H.L. Miller (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Cities for Climate Protection (CCP) Australia 2007, Local Government Action on Climate Change, CCP Australia Measures Evaluation Report 2007, ICLEI and Australian Greenhouse Office, Canberra.



COAG Climate Change Group 2005, National Climate Change Adaptation Framework, COAG, Canberra, accessed at http://www.coag.gov.au/meetings/130407/docs/national_climate_change_adaption_framework.pdf, 12 January 2008

CSIRO 2007, Climate Change in Australia - Technical Report 2007, CSIRO Canberra.

Cutter, SL, and Finch, C 2008, "Temporal and spatial changes in social vulnerability to natural hazards", PNAS, vol 105(7), pp. 2301-2306.

Depledge, M 2007, "Sea Change: Implications for human health and well-being", CoasteNet/Corepoint Conference, A very visible truth: climate Change at the Coast

Department of Communities and Local Government (DCLG) 2007 Planning Policy Statement: Planning and Climate Change. Supplement to Planning Policy Statement 1 (available from <http://www.communities.gov.uk/publications/planningandbuilding/ppsclimatechange>).

Dodson, J and Sipe, N 2005, Oil Vulnerability in the Australian City, Urban Research Program, Research Paper 6, December 2005

Duxbury, J and Dickinson, S 2007, "Principles for sustainable governance of the coastal zone: In the context of coastal disasters", Ecological Economics 63 (2007), pp. 317-330

England, P 2006, Climate Change: What are Local Governments Liable For? Urban Research Program Issues paper 6 March 2006

Ewing, R., Bartholomew, K., Winkelman, S., Walters, J. and Chen, D., *Growing Cooler: Evidence on Urban Development and Climate Change*, Urban Land Institute, <http://dnr.wi.gov/environmentprotect/qtfgw/documents/GrowingCoolerEs.pdf> (consulted 3rd March 2008).

Few, R 2007, "Health and climatic hazards: Framing social research on vulnerability, response and adaptation", Global Environmental Change, 17 (2007), pp. 281-295

Fisher, B. S., N. Nakicenovic, K. Alfsen, J. Corfee Morlot, F. de la Chesnaye, J. -Ch. Hourcade, K. Jiang, M. Kainurma, E. La Rovere, A. Mattsek, A. Rana, K. Riahi, R. Richels, S. Rose, D. van Vurren, R. Warren, 2007. In Climate Change 2007; Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P. R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

Footitt, A, Wood, R and Turnpenny, J, 2007, Review of Local Government Action on Climate Change, Local Government Association Climate Change Commission., Local Government Analysis and Research and Economic and Social Research Council, Norwich.

Freehills, 2007 An overview of recent Australian climate change litigation, available at http://www.freehills.com.au/publications/publications_6400.asp.

Gupta, S., D.A. Tirpak, N. Burger, J. Gupta, N. Hohne, A. I. Boncheva, G.M. Kanoan, C. Kolstad, J. A. Kruger, A. Michaelowa, S. Murase, J. Pershing, T. Saijo, A. Ssari, 2007, Policies, Instruments and Co-operative Arrangements. In Climate Change 2007; Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P. R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

Gurran, N, Blakely, E 2007, "Suffer a Sea Change? Contrasting Perspectives towards urban policy and migration in coastal Australia", Australian Geography 38(1) pp.113-132.

Gurran, N, Squires, C, Blakely, E 2005, "Meeting the Sea Change Challenge: Sea Change Communities in Coastal Australia", Report for the National Sea Change Task Force, Planning Research Centre, University of Sydney.



Gurran, N and Squires, C forthcoming, Meeting the Sea Change Challenge Update Report and Data Supplement 2008, Report prepared for the National Sea Change Taskforce, University of Sydney.

Hamilton, C and Mail, E 2003, Downshifting in Australia; A sea-change in the pursuit of happiness, Discussion Paper Number 50, The Australia Institute.

Hardy, N and Caton, B 2003, Coastal Management in Australia, Oxford University Press, Victoria

Hennessy, K. B. Fitzharris, B. C. Bates, N. Harvey, S. M. Howden, L. Hughes, J. Salinger, and R. Warrick, 2007, Australia and New Zealand, Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canzaiani. J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds, Cambridge University Press, Cambridge, UK, 507-540.

Holper Paul, Lucy, S, Nolan, M, Senese, C, Hennessy, K 2006, Infrastructure and Climate Change Risk Assessment for Victoria, CSRIO, Victoria.

Hotham, C 2005, Climate Change Resilient Communities: Building the capacity of communities to cope with Climate Change and resultant employment opportunities in a climate constrained future, Conservation Council of South Australia, Adelaide.

Intergovernmental Panel on Climate Change (IPCC) 2007a, Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability, Summary for Policy Makers, April 6 2007.

Intergovernmental Panel on Climate Change (IPCC) 2007b, Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Mertz, O.R. Davidson, P. R. Bosch, R. Dave, L.A. Meyer (eds)] Cambridge University Press, Cambridge, United Kingdom and New York, NY USA.

Intergovernmental Panel on Climate Change (IPCC) 2007c, Glossary of Terms used in the IPCC Fourth Assessment Report, available at: <http://www.ipcc.ch/glossary/index.htm>.

International Council for Local Environmental Initiatives (ICLEI) 2008, Strategies to Promote Solar (web materials), www.greenpowergovs.org/Solar_2strategies.html , accessed 21 January 2008

Levine, J., Esnard, A.M., Sapat, A. (2007) ' Population Displacement and Housing Dilemmas Due to Catastrophic Disasters', Journal of Planning Literature 22(1), pp. 4-15.

London Climate Change Partnership 2006, Adapting to Climate Change, Lessons for London, July 2006, London Climate Change Partnership, London.

Marcouiller, DW, Clendenning, JG, Kedzior, R (2002) Natural Amenity-Led Development and Rural Planning, Journal of Planning Literature v16(4) : 515-542.

Masozera, M, Bailey, M and Kerchner, C 2007, " Distribution of impacts of natural disasters across income groups: A case study of New Orleans", Ecological Economics 63(2007), pp. 299-306

New Zealand Climate Change Office 2004, Coastal Hazards and Climate Change, A guidance Manual for local government in New Zealand, New Zealand Climate Change Office, Wellington.

Norman, B The Australian Coast – A Matter of National Significance , keynote speech to WA Coastal Conference 2005.

Norman, B forthcoming, " From Integrated Coastal Management to Sustainable Coastal Planning", PhD Thesis, RMIT University, Melbourne.

Office of the Deputy Prime Minister (ODPM) 2004, The Planning Response to Climate Change; Advice on Better Practice, Office of the Deputy Prime Minister: London.

Planning Institute of Australia (PIA) 2002, Climate Change and Sustainability Project; Overview of Research into Adaptation to Climate Change through Planning; November 2002, PIA Queensland Division, Brisbane.

Planning Institute of Australia (PIA) 2007, Climate Change, National Position Statement 8, October 2007, Canberra



Planning Institute of Australia (PIA) Queensland Division 2004 'Adapting to Climate Change Impacts Paper' PIA, Brisbane.

Queensland Department of Natural Resources and Water 2007, ClimateSmart Adaptation 2007-12, Queensland Government, Brisbane.

Queensland Environmental Protection Authority 2003 Planning for Adaptation to Climate Change EPA QPWS), Queensland

Rogner, H. –H., D. Zhou, R. Bradley,. P. Crabbe, O. Edenhofer, B. Hare (Australia), L. Kuijpers, M. Yamaguchi, 2007: Introduction, In Climate Change 2007; Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P. R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

Rosenkoetter, M M, Krassen Covan, E, Cobb, B K, Bunting, S, and Weinrich, M 2007, " Perceptions of Older Adults Regarding Evacuation in the Event of a Natural Disaster", Public Health Nursing 24(2), pp. 160-168

SGS Economics and Planning 2007a, Impacts of Coastal Population Fluctuations, Department of Sustainability and Environment, Victoria.

SGS Economics and Planning 2007b, Socioeconomic Assessment and Response for Climate Change Impacts on Clarence Foreshores Interim Report, Clarence City Council, Tasmania.

Sharples, C 2006 Indicative Mapping of Tasmanian Coastal Vulnerability to Climate Change and Sea-Level Rise: Explanatory Report, Consultant Report to Department of Primary Industries and Water, Tasmania, 2nd Edn. May 2006.

Shumway J.M and Otterstrom S.M (2001) Spatial Patterns of Migration and Income Change in the Mountain West: The Dominance of Service-Based, Amenity-Rich Counties The Professional Geographer v53(4): 492-502

SKM (2007) Adapting to Climate Change A Queensland Local Government Guide, Report for the Local Government Association of Queensland, June 2007.

SMEC 2007, Climate Change Adaptation Actions for Local Government; Report to the Australian Greenhouse Office, Department of Environment and Water Resources, Canberra

Smit, B and Wandel, J 2006, " Adaptation, adaptive capacity and vulnerability", in Global Environmental Change 16(2006), pp. 282-292

Standards Australia / Standards New Zealand 2004, AS/NZS 4360:2004 – Risk Management. Standards Australia /, August 2004.

Stewart, S. I. 2000. Amenity migration. Trends 2000: Proceedings of the Fifth Outdoor Recreation and Tourism Trends Symposium (17-20 September). Michigan State University, East Lansing, MI.

The Heinz Centre 2007, A Survey of Climate Change Adaptation Planning The John Heinz III Centre for Science, Economics and the Environment, Washington DC, October 2007, http://www.heinzctr.org/NEW_WEB/PDF/Adaptation_Report_October_10_2007.pdf, accessed 20 January 2008

Thom, B 2007, Climate Change and the Coast: The Institutional Challenge; Climate Change Forum, Department of Primary Industries and Southern Rivers Catchment Management Authority, Bega and Nowra, 12-20 June 2007

Thomas, K, Rothwell, P, Mitchell, C, Donovan, B 2007, " Making Space for Water; Adapting to Climate Change and Sea Level Rise", CoasteNet/Corepoint Conference, A very visible truth: climate Change at the Coast

UK Local Government Association 2007, A Climate of Change; Report to the Local Government Climate Change Commission, accessed online at:



US Green Building Council 2008, <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1718>, accessed 15 March 2008.

Victorian Coastal Council, Draft Victorian Coastal Strategy (2007), at http://www.vcc.vic.gov.au/vcsdraft2007/VCS_Draft_FINAL.pdf accessed on 2 February 2008

Victorian Department of Human Services 2007, "Climate change and health: An exploration of challenges for public health in Victoria", Victorian Government, Melbourne, available at: http://www.health.vic.gov.au/environment/downloads/cc&h-challenges_public_health_vic.pdf, accessed on 19 January 2008.

Vogel, C, Moser, S C, Ksperson, R E, Dabelko, G D, 2007, "Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships", *Global Environmental Change* 17 (2007), pp. 349-364.

Voice, N, Harvey, N and Walsh, K 2006 (editors) *Vulnerability to Climate Change of Australia's Coastal Zone: Analysis of gaps in methods, data and system thresholds*, Report to the Australian Greenhouse Office, Canberra, June 2006.

Watkinson, A 2007, "Climate Change at the Coast – from local to local", keynote speech, CoasteNet/Corepoint Conference, A very visible truth: climate Change at the Coast

Welsh Assembly Government 2007, *Responding to Our Changing Climate: consultation on a climate change adaptation plan for Wales*, http://wales.gov.uk/docrepos/40382/4038231121/403828/1251865/Climate_change_21-52.pdf?lang=en, accessed 20 Jan 2009

World Wildlife Fund (WWF) and Insurance Australia Group 2008, *Climate Change Solutions for Australia*, available at: http://www.wwf.org.au/publications/acg_solutions/.



Appendix One: National Sea Change Taskforce Members

Sea Change Member Councils 2007

NSW	QLD	SA	TAS	VIC	WA
Ballina	Burnett	Alexandrina	Break O'Day	Bass Coast	A bany
Bega Valley	Caboolture	Copper Coast	Circular Head	Colac Otway	Augusta-Margaret R
Bellingen	Cairns	Onkaparinga	GlamorganSpring Bay	East Gippsland	Bunbury
Byron	Calliope	Robe	Kingborough	Glenelg	Busseton
Clarence Valley	Caloundra	Streaky Bay	Sorell	Moyne	Capel
Coffs Harbour	Douglas	Victor Harbor	Break O'Day	Sth Gippsland	Coorow
Eurobodalla	Gold Coast	Yankalilla		Surf Coast	Denmark
Gosford	Hervey Bay	Yorke Peninsula		Wellington	Esperance
Great Lakes	Livingstone				Exmouth
Greater Taree	Maroochy				Geraldton
Kempsey	Miriam Vale				Gingin
Kiama	Noosa				Irwin
Pt Macquarie-Hastings	Townsville				Mandurah
Port Stephens	Whitsunday				Rockingham
Richmond Valley					Wanneroo
Shoalhaven					
Wollongong					
Wyang					

Source: National Sea Change Taskforce 2007